INDEPENDENT ORBITER ASSESSMENT

ANALYSIS
OF THE
NOSE WHEEL STEERING
SUBSYSTEM

21 NOVEMBER 1986

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
HOUSTON DIVISION

SPACE TRANSPORTATION SYSTEM ENGINEERING AND OPERATIONS SUPPORT

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INDEPENDENT ORBITER ASSESSMENT ANALYSIS OF THE NOSE WHEEL STEERING SUBSYSTEM

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1.0 EXECUTIVE SUMMARY

The McDonnell Douglas Astronautics Company (MDAC) was selected in June 1986 to perform an Independent Orbiter Assessment (IOA) of the Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL). Direction was given by the STS Orbiter and GFE Projects Office to perform the hardware analysis using the instructions and ground rules defined in NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. The IOA approach features a top-down analysis of the hardware to determine failure modes, criticality, and potential critical items. To preserve independence, this analysis was accomplished without reliance upon the results contained within the NASA FMEA/CIL documentation. This report documents (Appendix C) the independent analysis results for the Orbiter Nose Wheel Steering (NWS) hardware.

The NWS hardware provides primary directional control for the Orbiter vehicle during landing rollout. The system consists of the following components:

- Steering Control Box (SCB)
- Rudder Pedal Assemblies (RPA)
- Steering Actuator Assembly
- Failure Annunciator System
- Activation System
- Multiplexer/Demultiplexers (MDM)

The IOA analysis process utilized available NWS hardware drawings and schematics for defining hardware assemblies, components, and hardware items. Each level of hardware was evaluated and analyzed for possible failure modes and effects. Criticality was assigned based upon the severity of the effect for each failure mode.

Figure 1 presents a summary of the failure criticalities for each of the seven major subdivisions of the NWS. A summary of the number of failure modes, by criticality, is also presented below with Hardware (HW) criticality first and Functional (F) criticality second.

Summary of IOA Failure Modes By Criticality (HW/F)

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Number :	6	36	-	15	-	21	78

NWS OVERVIEW ANALYSIS SUMMARY

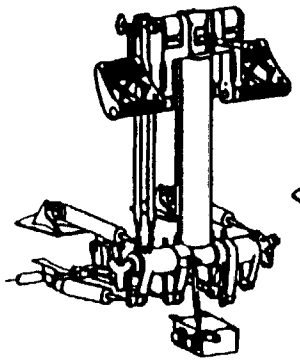
NWS ANALYSIS SUMMARY					
CRIT.	#FM	#PCI	CRIT.	#FM	#PCI
1/1	6	6	3/1R	15	0
2/1R	36	36	3/3	21	NA

RUDDER PEDAL ASSEMBLIES

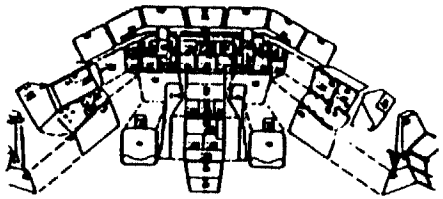
CRIT.	#FM	#PCI
1/1	1	1
2/1R	5	5
3/1R	2	NA

ACTIVATION SYSTEM

CRIT.	#FM	#PCI
1/1	1	1
2/1R	2	2
3/1R	1	0
3/3	6	NA



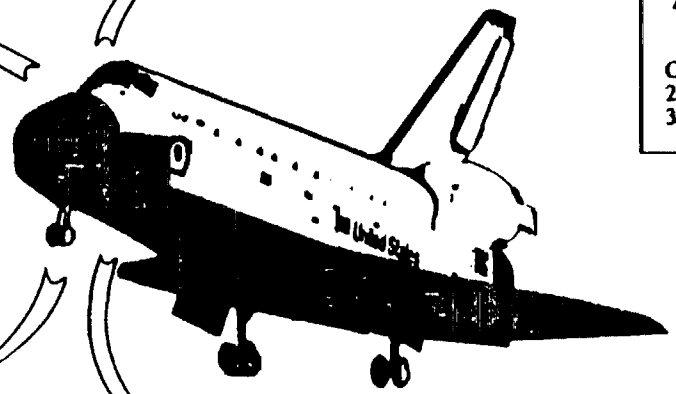
RUDDER PEDAL ASSEMBLY



FLIGHT STATION

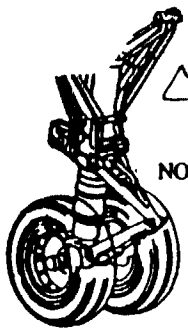
FAILURE ANNUNCIATOR SYSTEM

CRIT.	#FM	#PCI
2/1R	2	2
3/3	3	NA



STEERING ACTUATOR ASSEMBLY

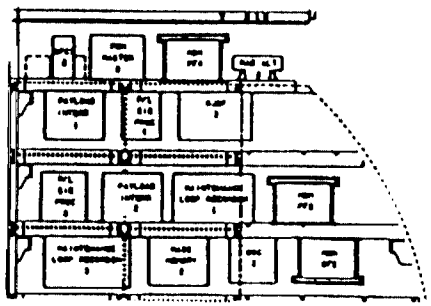
CRIT.	#FM	#PCI
1/1	4	4
2/1R	19	19
3/1R	4	0
3/3	10	NA



NOSE WHEEL

FLIGHT FORWARD MULTIPLEXER/ DEMULTIPLEXERS

CRIT.	#FM	#PCI
2/1R	4	4
3/1R	8	0



AVIONICS BAY

STEERING CONTROL BOX

CRIT.	#FM	#PCI
2/1R	4	4
3/3	2	NA

CRIT - CRITICALITY
FM - FAILURE MODE
PCI - POTENTIAL CRITICAL ITEM

Figure 1 - NWS OVERVIEW ANALYSIS SUMMARY

For each failure mode identified, the criticality and redundancy screens were examined to identify critical items. A summary of potential critical items is presented as follows:

Summary of IOA Potential Critical Items (HW/F)						
Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Number :	6	36	-	-	-	42

The original NWS design was envisioned as a backup system to differential braking for directional control of the Orbiter during landing rollout. No real effort was made to design the NWS system as fail operational. The brakes have much redundancy built into their design but the poor brake/tire performance has forced the NSTS to upgrade NWS to the primary mode of directional control during rollout. As a result, a large pecentage of the NWS system components have become Potential Critical Items (PCI). This current state of conditions will continue to exist until the planned NWS system redesign (Phase III upgrade) is implemented.

2.0 INTRODUCTION

2.1 Purpose

The 51-L Challenger accident prompted the NASA to readdress safety policies, concepts, and rationale being used in the National Space Transportation System (NSTS). The NSTS Office has undertaken the task of reevaluating the FMEA/CIL for the Space Shuttle design. The MDAC is providing an independent assessment of the Orbiter FMEA/CIL for completeness and technical accuracy.

2.2 Scope

The scope of the independent FMEA/CIL assessment activity encompasses those Shuttle Orbiter subsystems and GFE hardware identified in the Space Shuttle Independent FMEA/CIL Assessment Contractor Statement of Work. Each subsystem analysis addresses hardware, functions, internal and external interfaces, and operational requirements for all mission phases.

2.3 Analysis Approach

The independent analysis approach is a top-down analysis utilizing as-built drawings to breakdown the respective subsystem into components and low-level hardware items. Each hardware item is evaluated for failure mode, effects, and criticality. These data are documented in the respective subsystem analysis report, and are used to assess the NASA and Prime Contractor FMEA/CIL reevaluation results. The IOA analysis approach is summarized in the following Steps 1.0 through 3.0. Step 4.0 summarizes the assessment of the NASA and Prime Contractor FMEAs/CILs that is performed and documented at a later date.

Step 1.0 Subsystem Familiarization
- 1.1 Define subsystem functions
- 1.2 Define subsystem components
- 1.3 Define subsystem specific ground rules and assumptions

Step 2.0 Define subsystem analysis diagram
- 2.1 Define subsystem
- 2.2 Define major assemblies
- 2.3 Develop detailed subsystem representations

Step 3.0 Failure events definition
- 3.1 Construct matrix of failure modes
- 3.2 Document IOA analysis results

Step 4.0 Compare IOA analysis data to NASA FMEA/CIL
- 4.1 Resolve differences
- 4.2 Review in-house
- 4.3 Document assessment issues
- 4.4 Forward findings to Project Manager

2.4 NWS Ground Rules and Assumptions

The NWS ground rules and assumptions used in the IOA are defined in Appendix B. The subsystem specific ground rules were defined to correct ommissions and clarify ambiguities.

3.0 SUBSYSTEM DESCRIPTION

3.1 Design and Function

The NWS hardware provides the primary directional control for the Orbiter during landing rollout. Deflection of the rudder pedals transmits electrical steering signals to the NWS Control Box. These electrical signals meter hydraulic power through the NWS Actuator which physically displaces the actuator piston. The piston, which is mechanically linked to the nose wheel collar, can rotate the nose wheel through +/- 10 degrees for directional control during rollout.

3.2 NWS Modes

The three modes of NWS operation are: 1) General Purpose Computer (GPC), 2) Direct (Manual), and 3) Free Castor. The GPC mode of NWS is now the primary mode of directional control during landing rollout. The GPC processes the steering signals before sending them to the SCB. The GPC mode also has a triple channel wraparound position feedback system with compare logic in the software. This added redundancy was a key factor in elevating NWS to its present status. The Direct mode of NWS uses its own command transducer (xducer) and the steering signals bypass the computer and go directly to the SCB. In the free castor mode of NWS, the NW rotates freely and steering is accomplished by differential braking and use of the rudder. During free castor, the hydraulic system has an internal damping capability which prevents the NW from shimmy oscillations.

3.3 Steering Timeline

The steering timeline is important to the analysis because some failure modes have different effects and criticalities depending on when the failure occurs. The GPC mode of NWS is selected during the final approach phase of landing. Between main gear touchdown (MGTD) and nose gear touchdown (NGTD), all directional control is performed by the rudder. Simulations at the NASA Ames moving base simulator have shown that when the crew applied the brakes while the nose wheel was in the air, it led to an uncontrollable negative pitching moment that resulted in large pitch rates at NGTD that would structurally damage the NW strut. Following NGTD, NWS is active and operates in tandem with the rudder. The rudder effectiveness decreases as the Orbiter decelerates, becoming essentially ineffective at about 75 knots airspeed. Braking may begin at about 150 knots ground speed. Studies and flight data have shown that initiating braking at higher speeds will result in brake/tire failures.

3.4 NWS Effectiveness

Steering with the NW takes advantage of an effective moment arm about five times as long as that available when using differential braking. The turning capability using only differential braking is not adequate to maintain directional control of the Orbiter for a landing scenario with blown tires. This inadequacy has contributed to the recent upgrades to the NWS requirements.

3.5 NWS Upgrades

A three phase upgrade to NWS was initiated with the goal of making the system fail operational/fail safe. Phase I upgrade consisted of rewiring the GPC and Direct positions on the NWS switch, disconnecting the GPC contact, and adding a 2.5 inch extension to the switch toggle. The rewiring inhibited the GPC mode and the extension made the task of turning on Direct, which must be done after NGTD, a little easier. The Phase II upgrade was implemented on flights STS-61A, STS-61C, and STS-51L. It primarily consisted of reconnecting the GPC switch contact and adding the wraparound FB system that includes Redundancy Management (RM) for operational control and failure detection logic. Parabolic signal shaping was also added to the command xducer steering signal (Direct mode of NWS). This is the current design and was used in the analysis. The Phase III upgrade is in the early design stage. Until the NWS redesign has eliminated all the single point failure modes, the system is at best fail safe.

3.6 NWS Component Description

The following sections highlight the major components of NWS: (Reference Figure 2)

1. The SCB has a single electrical power source, Main Bus A. At NGTD the GPC issues enable signals that trigger the SCB to route this power to the pilot valve solenoids in the steering actuator assembly. The steering signal current is monitored in the SCB before being transmitted to the steering actuator system. The SCB contains five separate failure detection circuits that monitor potential NWS failure modes. Any one failure detection will automatically downmode NWS to the free castor mode and annunciate the fail light. (Reference Figure 3).

2. The RPA consist of the commander's and pilot's rudder pedals and linkages, two rudder pedal transducer assemblies (RPTA), one NWS command transducer and four brake pedal position transducers. The commander's and pilot's rudder pedals are mechanically linked to each other and to the transducers. Steering signals are proportional to the translational deflection of the rudder pedals. Braking signals are proportional to the rotational (toe) deflection of the rudder pedals. Rudder commands are independent of NWS (Reference Figure 4).

3. The NWS Actuator Assembly converts electrical steering signals into a displacement of the actuator arm which is mechanically linked to the NW. Hydraulic system No.1 provides 3000 psi fluid to the NWS actuator. The fluid is filtered before it reaches the shutoff valve. Pilot valve No.1 opens or closes the shutoff valve. Pilot valve No.2 opens or closes the Bypass/Control valves. Both pilot valves must be open to energize the system; if either one closes, the system downmodes to the free castor mode. Once the hydraulic pressure in the actuator reaches 1350 psi, a pressure sensitive switch closes which inhibits the hardwired electrical path to the NWS fail light. If the pressure falls below 1000 psi, the pressure switch will close and annunciate the fail light.
After the system is energized, the electro-hydraulic (EH) servo valve meters high pressure flow proportional to the steering signal transmitted by the SCB. The high pressure drives the actuator piston/arm which is attached to a collar on the nose gear strut which rotates the torque link and the NW. A feedback xducer provides "steering velocity" data to the SCB which is used in one of the failure detection circuits. In the GPC mode, the steering position transducer (SPT) and steering position amplifier (SPA) provide NW position data which is used by the GPC failure detection logic in the NW Subsystem Operating Program (SOP).
System protection against high pressure is provided by two overload check valves and a return line check valve. Low system pressure required for shimmy damping during free castor is provided by the accumulator through the anti-cavitation check valves (Reference Figure 5).

4. The Failure Annunciator System illuminates a NWS fail light which warns the crew that a detectable failure has occurred or that the NWS system may be unreliable. A subsystem specific groundrule was written stating that the crew will respond the the annunciated fail light by manually downmoding NWS to free castor. Control Bus AB1 provides power to a Type III hybrid circuit driver which will allow annunciator circuit lamp power to illuminate the NWS fail light. The fail signal may originate in either the hardwired path from the pressure switch or the MDM FF4 path from the NW Position SOP. In the GPC mode the hardwired path is inhibited until NGTD (Reference Figure 6).

5. The Activation System was included to maintain a more complete NWS analysis. The single power source for NWS is Main Bus A. The NWS toggle switch must be in the GPC or Direct position for power to enter the system. A circuit breaker provides protection against high voltage/current spikes. The ROLL/YAW CSS/AUTO PBIs configure a flight control channel that determines whether the steering signals originate at the rudder pedals or in autoland guidance. The activation system also has a current limit resistor in line with the fail light power source CNTL AB1. There are three isolation resistors providing circuit protection to MDM lines that monitor the power lines (Reference Figure 7).

6. The Data Processing System (DPS) Flight Critical Forward MDMs were included in this analysis because of the strong dependence NWS has on the health of this interfacing subsystem. Many of the NWS commands and signals are transmitted via the flight critical MDMs. The MDMs act as data aquisition, distribution and signal conditioning units. This analysis will only consider single data path failures (Reference Figure 8).

Above Items 4 and 5 interface with the Electrical Power and Distribution Control (EPD&C) system. Item 6 interfaces with the Orbiter DPS system. This document contains only a partial analysis of these interfacing components. The analysis examines only the NWS related effects of these component failure modes.

3.7 Interfaces and Locations

All of the major NWS components are located in one of three locations on the Orbiter. The Activation System, the Failure Annunciation System, and the Rudder Pedal Assemblies are located on the Flight Deck. The NWS Control Box and Actuator Assembly are both attached to the nose gear strut. The GPCs and the Flight Forward MDMs are all located in Avionics Bays 1, 2, and 3. (Reference Figure 9).

3.8 Hierarchy

Figure 2 illustrates the hierarchy of the NWS hardware. Figures 3 through 8 comprise the detailed system representations.

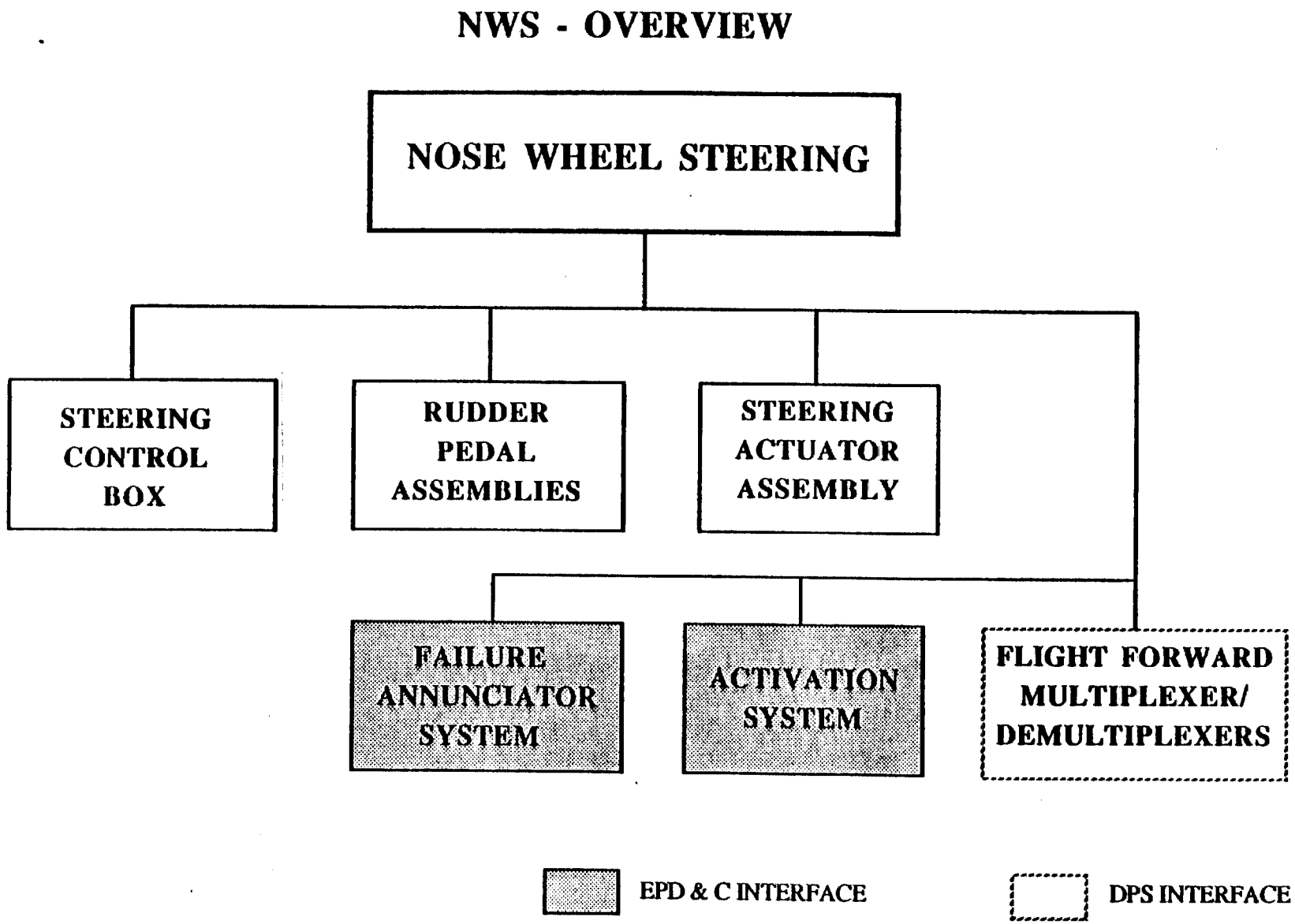


Figure 2 - NWS OVERVIEW

NWS - STEERING CONTROL BOX

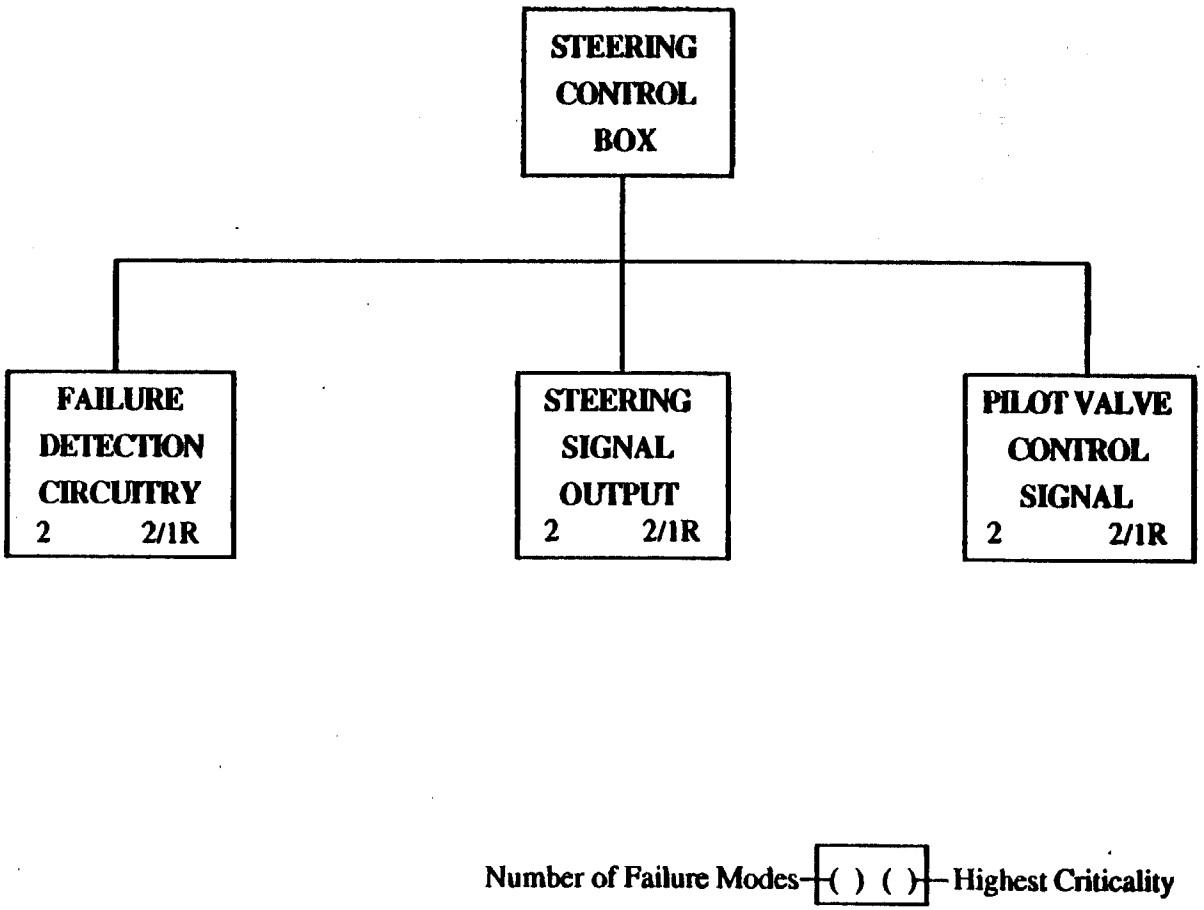


Figure 3 - NWS STEERING CONTROL BOX

NWS - RUDDER PEDAL ASSEMBLIES

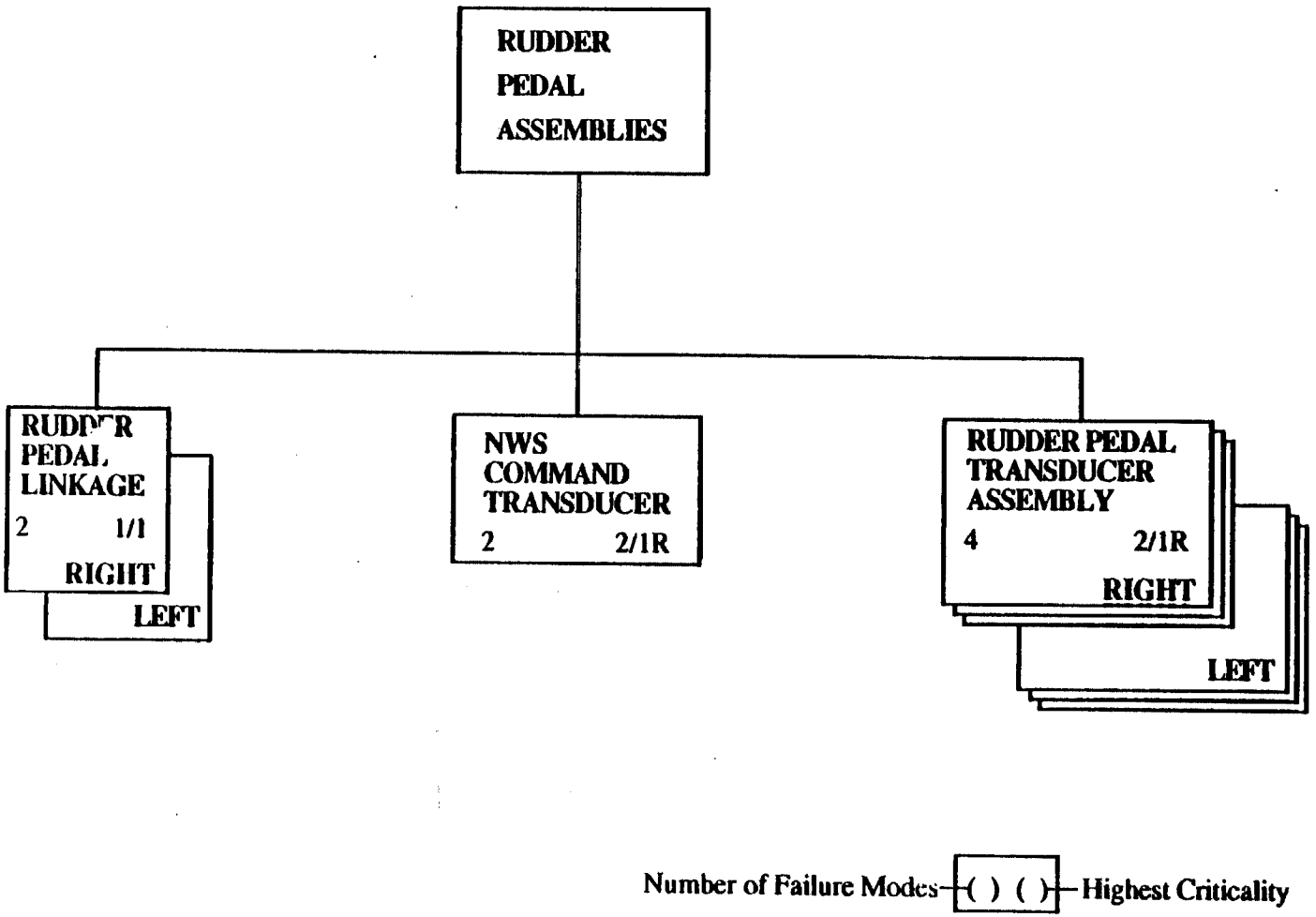


Figure 4 - NWS RUDDER PEDAL ASSEMBLIES

NWS - STEERING ACTUATOR ASSEMBLY

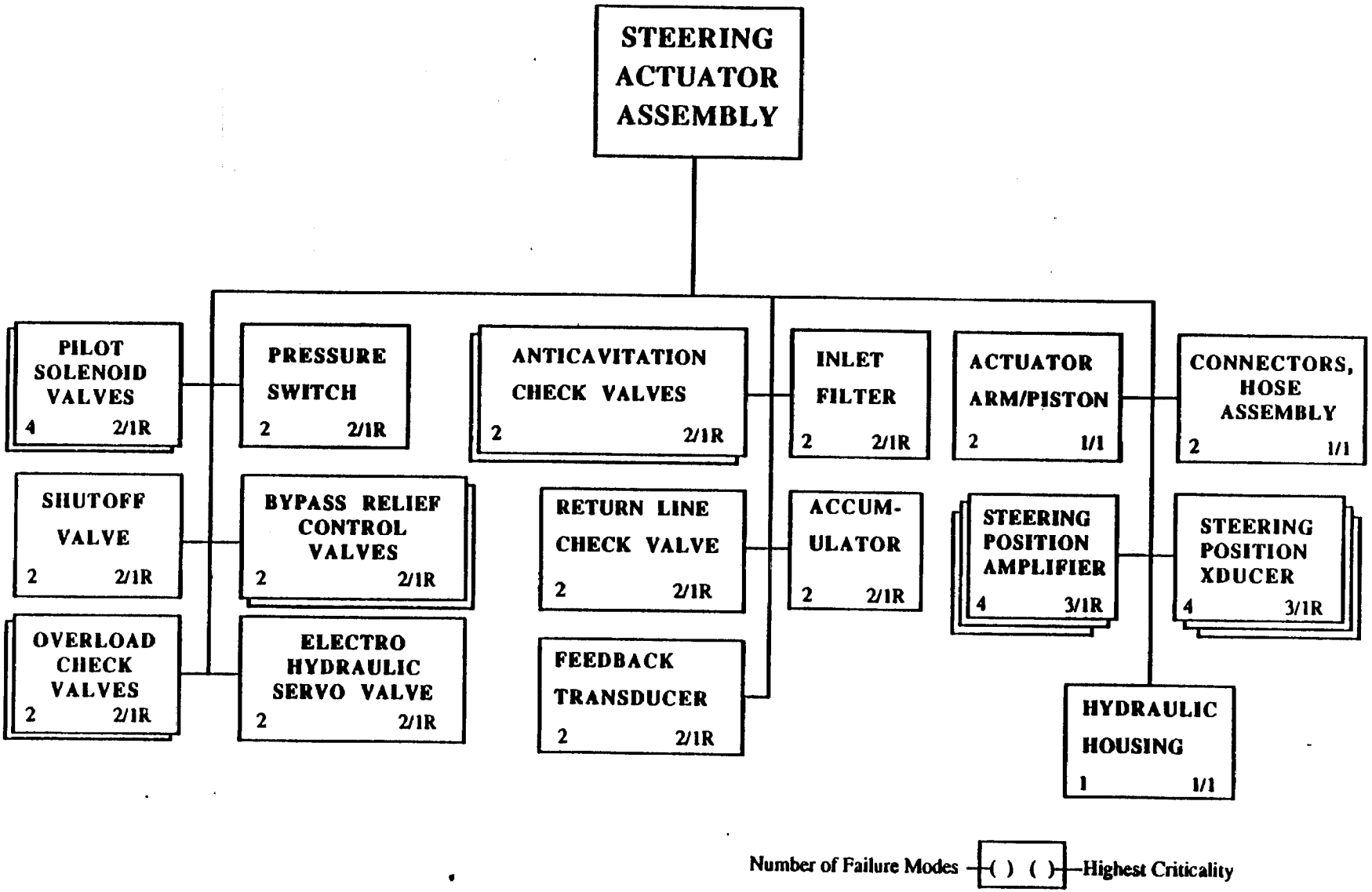


Figure 5 - NWS STEERING ACTUATOR ASSEMBLY

NWS - FAILURE ANNUNCIATOR SYSTEM

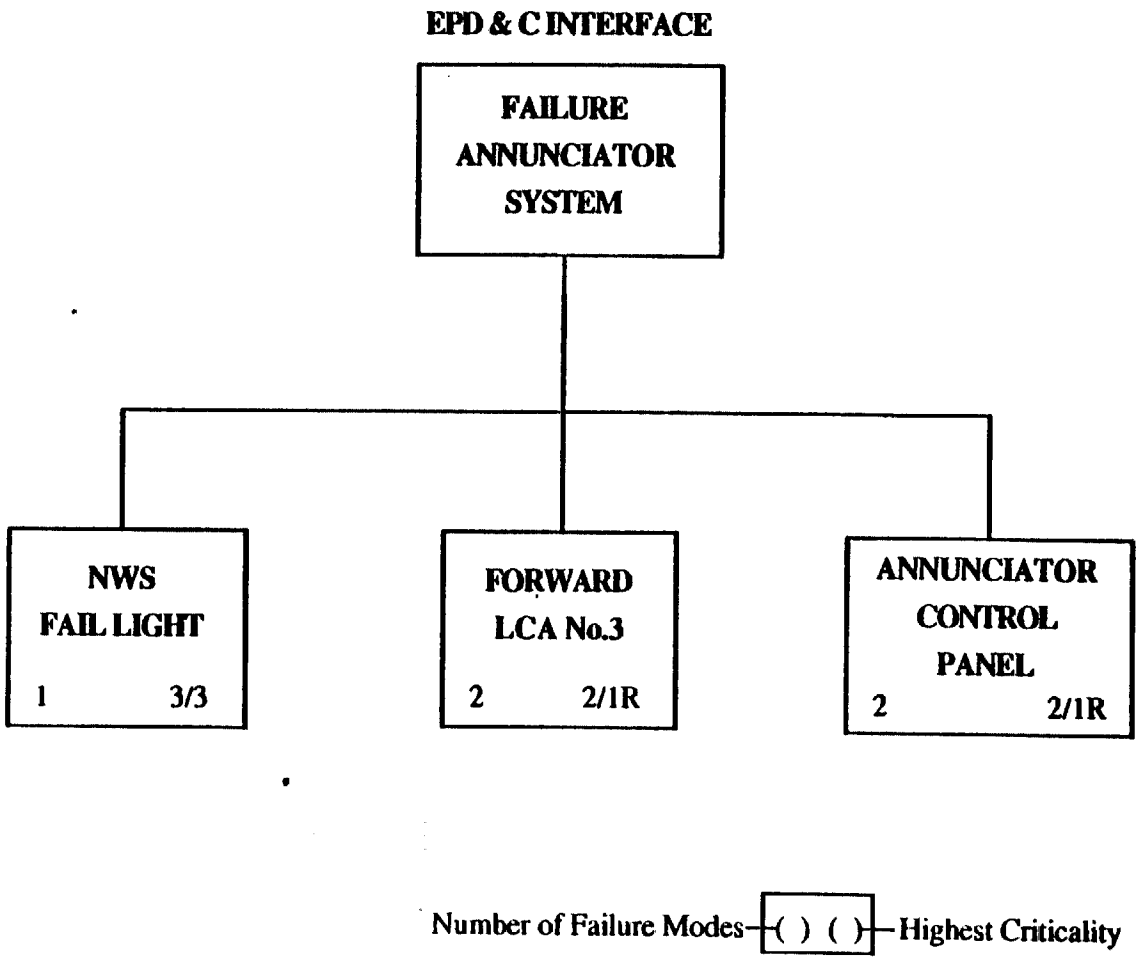


Figure 6 - NWS FAILURE ANNUNCIATION SYSTEM

NWS - ACTIVATION SYSTEM

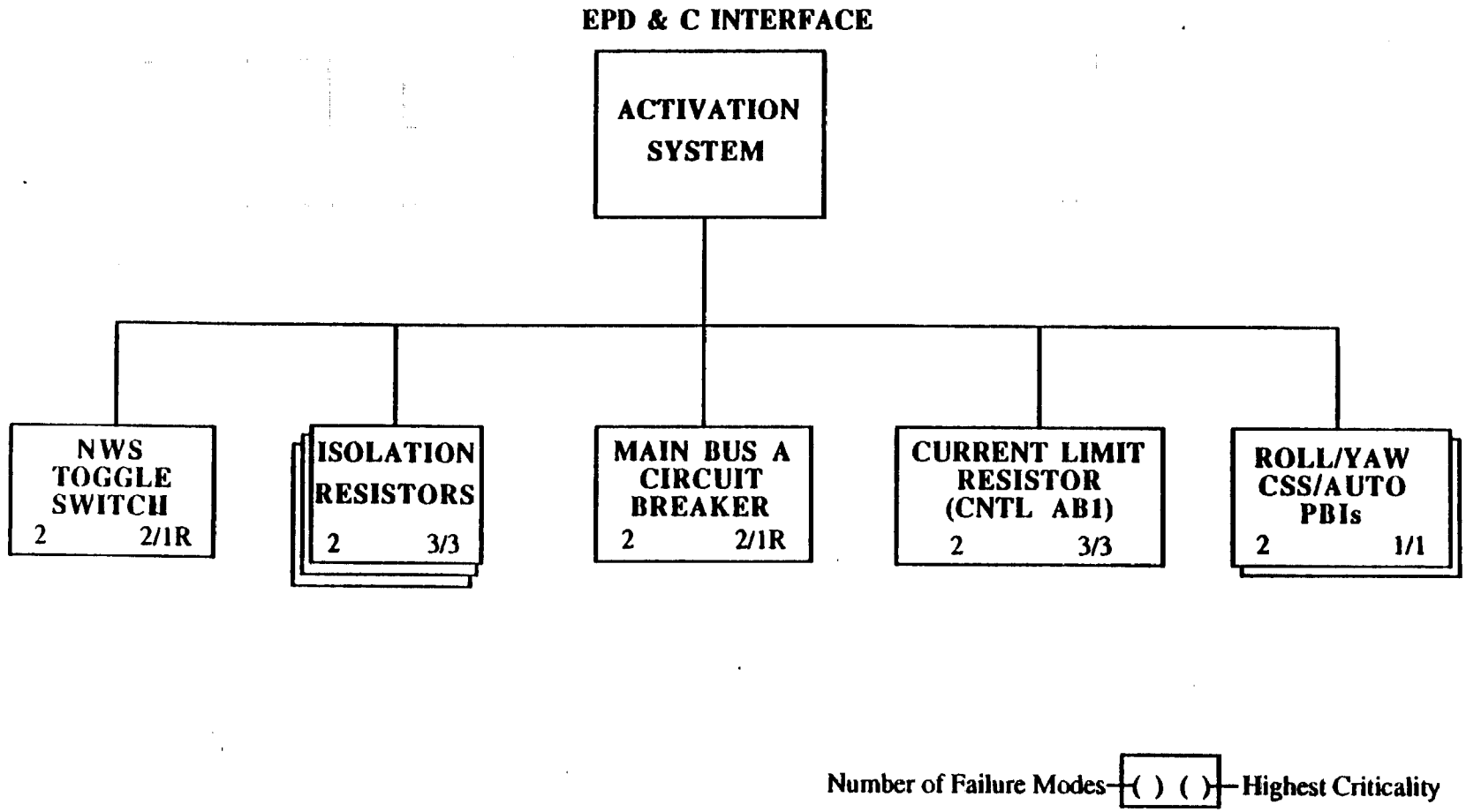


Figure 7 - NWS ACTIVATION SYSTEM

NWS - FLIGHT FORWARD MULTIPLEXER/DEMULTIPLEXERS

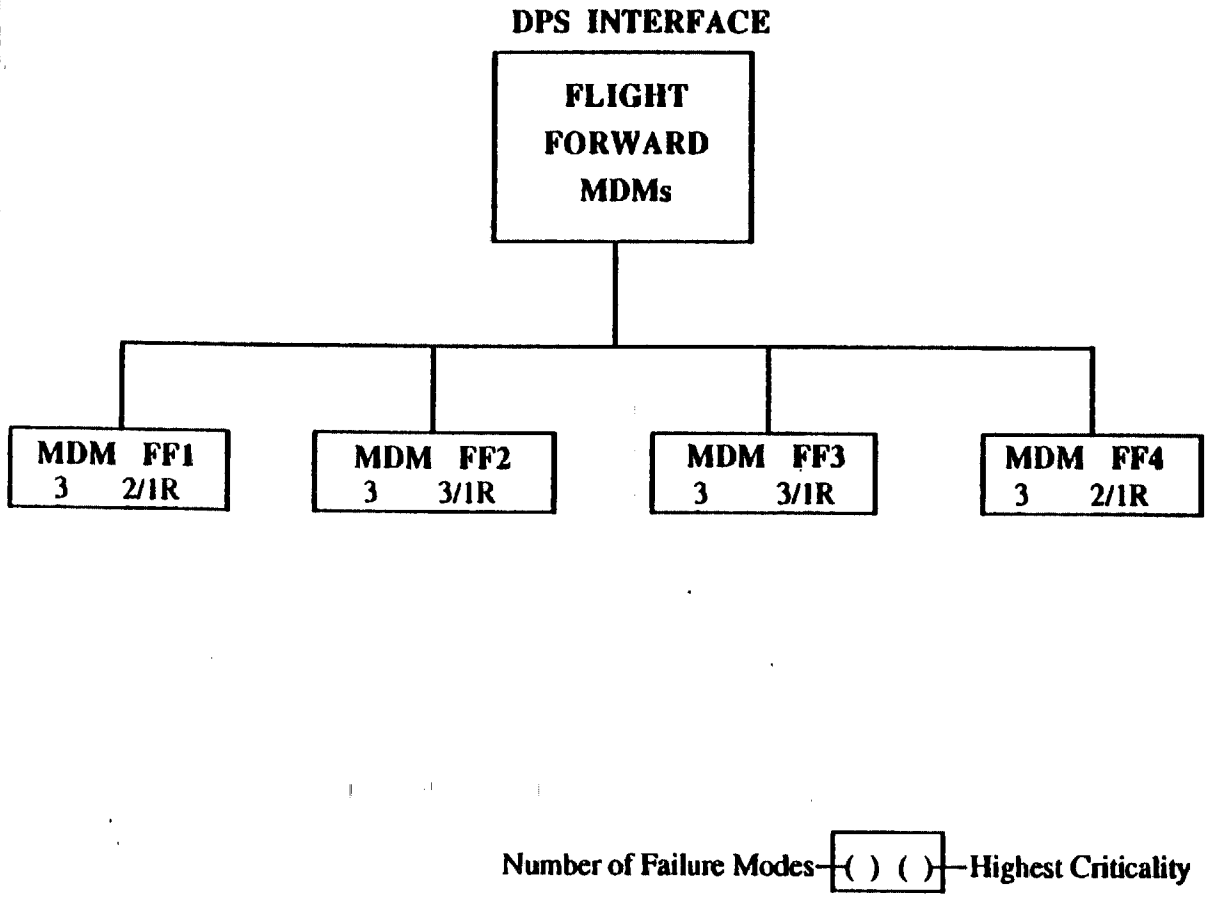


Figure 8 - NWS FLIGHT FORWARD MULTIPLEXER/DEMULTIPLEXERS

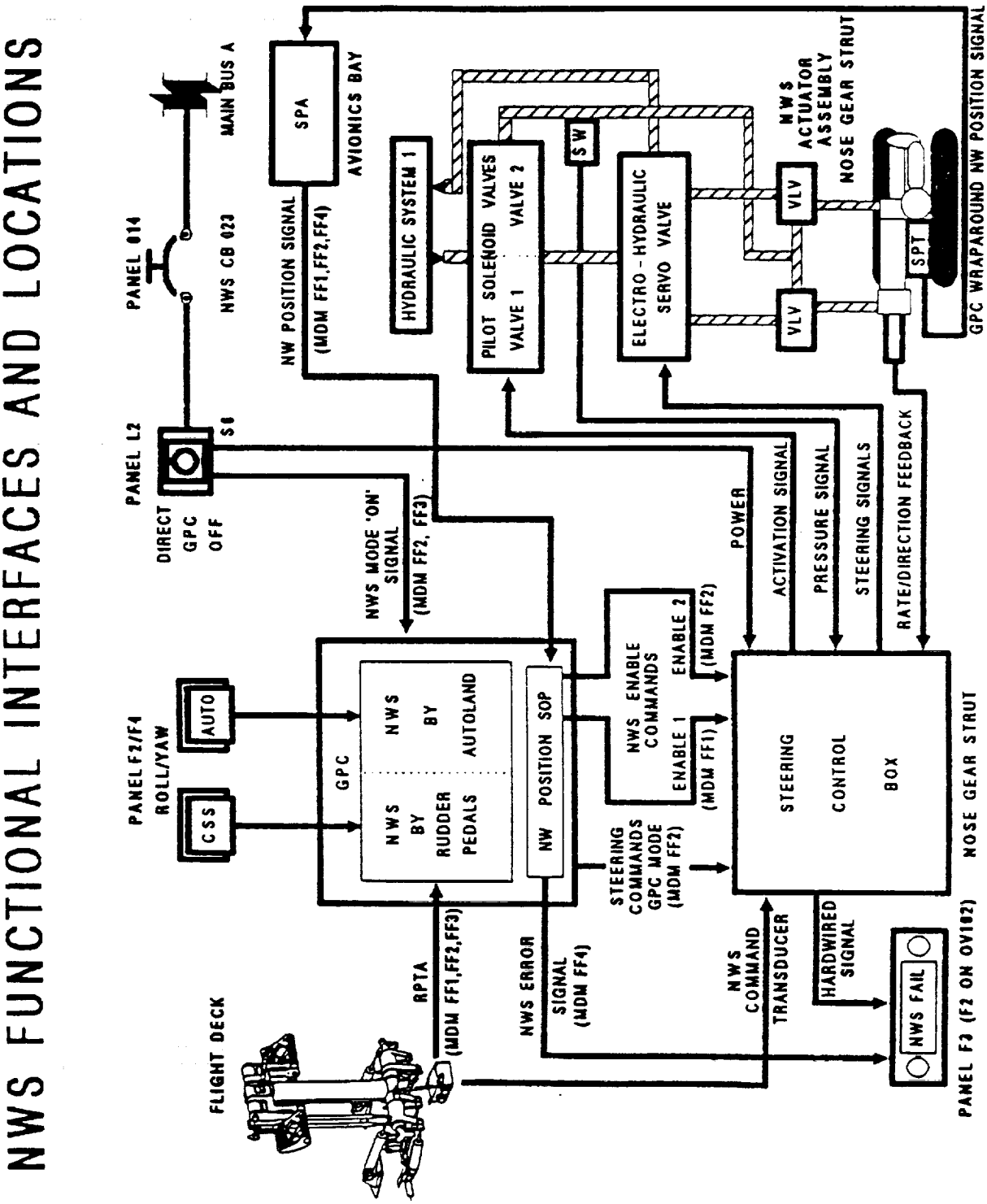


Figure 9 - NWS FUNCTIONAL INTERFACES AND LOCATIONS

4.0 ANALYSIS RESULTS

Detailed analysis results for each of the identified failure modes are presented in Appendix C. Table I presents a summary of the failure criticalities for each of the six major subdivisions of the NWS. Further discussion of each of these subdivisions and the applicable failure modes is provided in subsequent paragraphs.

TABLE I Summary of IOA Failure Modes and Criticalities

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	3/3	TOTAL
Rudder Pedal Assemblies	1	5	-	2	-	-	8
NWS Control Box	-	4	-	-	-	2	6
NWS Actuator Assembly	4	19	-	4	-	10	37
NWS/EPD&C Failure Annunciation System	-	2	-	-	-	3	5
NWS/EPD&C Activation System	1	2	-	1	-	6	10
NWS/DPS Flight Forward MDMs	-	4	-	8	-	-	12
TOTAL	6	36	-	12	-	24	78

Of the 78 failure modes analyzed, 42 failures were determined to be Potential Critical Items (PCI). A summary of the PCIs is presented in Table II. Appendix D presents a cross reference between each PCI and a specific worksheet in Appendix C.

TABLE II Summary of IOA Potential Critical Items

Criticality:	1/1	2/1R	2/2	3/1R	3/2R	TOTAL
Rudder Pedal Assemblies	1	5	-	-	-	6
NWS Control Box	-	4	-	-	-	4
NWS Actuator Assembly	4	19	-	-	-	23
NWS/EPD&C Failure Annunciation System	-	2	-	-	-	2
NWS/EPD&C Activation System	1	2	-	-	-	3
NWS/DPS Flight Forward MDMs	-	4	-	-	-	4
TOTAL	6	36	-	-	-	42

4.1 THE RUDDER PEDAL ASSEMBLIES (RPA)

The analysis of the RPA examined the failure modes for the rudder pedals, the RPTAs, and the command transducer. The rudder pedals are a linkage system whose transducer measured deflections control NWS, the rudder, and the brakes. The Orbiter relies solely on the rudder for directional control between MGTD and NGTD. If the rudder pedals jammed during this phase of landing, it could result in the loss of the Orbiter. For this reason, a criticality of 1/1 was assigned to this failure mode. The RPTA and command transducer signal outputs were failed in two modes: no output and erroneous output. The failure of these transducer signals results in the loss of NWS and/or rudder control. The highest criticality assigned to the transducer failures was 2/1R. Out of a total of eight failure modes examined for the RPA, six PCIs have been identified in Appendix D.

4.2 THE STEERING CONTROL BOX (SCB)

Schematics of the SCB 'as-built' are considered proprietary by the customer and were not available for this study. The SCB analysis considered the failure of the three primary functions of the control box: NWS command output, NWS pilot valve actuation, and NWS failure detection.
Of the six failure modes examined, four were assigned criticalities of 2/1R. These failure modes resulted in the automatic downmoding of NWS to free castor leaving only differential braking to be relied upon for directional control. These four PCIs have been identified in Appendix D.

4.3 THE STEERING ACTUATOR ASSEMBLY

The Steering Actuator Assembly has by far the largest number of components in the NWS system. Electronic hardware and various types of hydraulic hardware were included in the actuator analysis.
The NWS capability is lost should the actuator piston that turns the nose wheel jam. If the jam occurs when the nose wheel is turned through some large angle, differential braking may not provide enough turning force to overcome the effects of the nose wheel deflection. This possible loss of vehicle led to a criticality assignment of 1/1 for this failure mode.
The GPC and Direct modes of NWS both use the actuator in order to control the nose wheel. One of various valve subcomponents of the actuator failing closed usually results in the loss of the NWS capability leaving only differential braking to be relied upon for directional control. As a result, there are twenty criticalities of 2/1R for the actuator.
A broken actuator piston linkage or a rupture in either the actuator housing or hydraulic lines can cause the loss of all NWS and shimmy damping capabilities and result in the loss of the Orbiter. These failure modes were assigned criticalities of 1/1. Those failures that result in the total loss of shimmy damping capability (Accumulator) but do not affect NWS were assigned criticalities of 2/1R based on the subsystem specific groundrule No. 8 (See Appendix B).
Components whose failure modes result in the loss of only the GPC mode of NWS (SPA,SPT) were assigned criticalities of 3/1R.
Out of a total of thirty-seven failure modes examined for the actuator assembly, twenty-three PCIs have been identified in Appendix D.

4.4 THE NWS/EPD&C FAILURE ANNUNCIATION SYSTEM

The NWS/EPD&C Failure Annunciation Subsystem is comprised of a fail light, a control assembly, and a hybrid driver. The two failure modes that resulted in the annunciation of the fail light were assigned a criticality of 2/1R based on the subsystem specific ground rule No. 7 (See Appendix B). Out of the five failure modes examined in this subsystem, two PCIs have been identified in Appendix D.

4.5 THE NWS/EPD&C ACTIVATION SYSTEM

The NWS/EPD&C Activation Subsystem consists of the NWS toggle switch, the NWS circuit breaker, the CSS/AUTO PBIs, and resistors.

Jamming a CSS/AUTO PBI to the AUTO contact reconfigures Flight Control (DAP) and causes the loss of all manual rudder control for the vehicle. The Orbiter relies solely on the rudder for directional control between MGTD and NGTD. When landing in the AUTO mode, Autoland Guidance requires a Microwave Scanning Beam Landing System (MSBLS) for the generation of effective rudder commands. Because a MSBLS is not available at all runways (Flight Rules only require a MSBLS for night landings), failure to AUTO can result in the possible loss of the Orbiter. The failure can be corrected by holding the CSS PBI depressed; however, this corrective action is not defined by nominal crew procedures. Because off-nominal crew procedures are not considered in assigning criticalities, a criticality of 1/1 was assigned to this failure mode.

Failing the toggle switch off or the circuit breaker open removes power from the NWS system leaving only differential braking to be relied upon for directional control. These failures were assigned criticalities of 2/1R. Out of the ten failure modes examined for this subsystem, three PCIs have been identified in Appendix D.

4.6 THE NWS/DPS FLIGHT FORWARD MDMs

MDMs FF1, FF2, FF3, and FF4 were examined in this analysis because their function is essential to the operation of the NWS system. The lowest criticality assigned to an MDM failure in this analysis was 3/1R. Four failure modes that result in the loss of both active modes of NWS have criticalities of 2/1R. Out of the twelve failure modes examined for the MDMs, four PCIs have been identified in Appendix D.

5.0 REFERENCES

Reference documentation available from NASA, Rockwell and Sterer was used in the analysis. The documentation used included the following:

1. JSC-11174, Space Shuttle Systems Handbook, Rev C-6, 3 NWS, 10-26-85.

2. DF NO1# DF4/86-14, Nose Wheel Steering Interim Upgrade, 2-24-86.

3. VS70-510219, Rockwell-Schematic Diagram - Nose Wheel Steering Subsystem, 8-6-85.

4. SK54400, Steerer-Schematic-S&D Subsystem Space Shuttle Electric, Rev F, 12-13-75.

5. 54400, Sterer-Steering and Damping Subsystem, Nose Wheel, Rev L, 7-31-80.

6. TD-159-A131, JSC Training Manual - Landing Deceleration 2102, 2-22-83.

7. JSC-12770, Shuttle Flight Operations Manual, Volume 10D - Landing/Deceleration, Revised 7-19-82.

8. KMO-983-62, Sterer-Shuttle Nose Wheel Steering and Damping Subsystem-Rockwell Specification, 9-6-83.

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11. JSC-18341, Subsystem Brief - Landing Deceleration, Mech Vol II, Rev A, 2-28-85.

12. NSTS 22206, Instructions for Preparation of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL), 10-10-86.

13. JSC-12820, STS Operational Flight Rules, PCN-1, 2-14-86.

14. STS 83-0007A, Space Shuttle Operational Level C FSSR GN&C Part C - Flight Control Entry - GRTLS, 6-30-85.

15. STS 83-0010A, Space Shuttle Operational Level C FSSR GN&C Part D Redundancy Management, 6-30-85.

16. STS 83-0015A, Space Shuttle Operational Level C FSSR GN&C Part E Subsystem Operating Programs Flight Control Sensor/ Controller, 6-30-85.

APPENDIX A
ACRONYMS

AOA - Abort Once Around
ATO - Abort To Orbit
AUTO - Autoland Guidance Computer Configuration
BFS - Backup Flight System
BITE - Built-In Test Equipment
CHNL - Channel
CIL - Critical Items List
CMD - Command, Commander
CNTL - Control
CRIT - Criticality
CSS - Control Stick Steering
DDU - Display Driver Unit
DPS - Data Processing System
EH - Electro-Hydraulic
ERR - Error
ENA - Enable
EPD&C - Electrical Power Distribution and Control
ET - External Tank
F - Functional
FB - Feedback
FF - Flight Forward
FM - Failure Mode
FMEA - Failure Mode and Effects Analysis
GNC - Guidance Navigation and Control
GPC - General Purpose Computer
HDW - Hardware
HW - Hardware
HYD - Hydraulic
IOA - Independent Orbiter Assessment
LRU - Line Replaceable Unit
MAN - Manual (Direct Mode of NWS)
MDAC - McDonnell Douglas Astronautics Company
MDM - Multiplexer/Demultiplexer
MGTD - Main Gear Touchdown
MM - Major Mode
MSBLS - Microwave Scanning Beam Landing System
NA - Not Applicable
NASA - National Aeronautics and Space Administration
NGTD - Nose Gear Touchdown
NSTS - National Space Transportation System
NW - Nose Wheel
NWS - Nose Wheel Steering
OMRSD - Operational Maintenance Requirements and Specifications Document
PBI - Push Button Indicator
PCI - Potential Critical Item
PLT - Pilot
POS - Position
RI - Rockwell International
RM - Redundancy Management
RPA - Rudder Pedal Assembly
RPTA - Rudder Pedal Transducer Assembly

RTLS - Return To Launch Site
SCB - Steering Control Box
SM - Systems Management
SOP - Subsystem Operating Program
SPA - Steering Position Amplifier
SPT - Steering Position Transducer
SRB - Solid Rocket Booster
STS - Space Transportation System
SV - Servo Valve
TAL - Transoceanic Abort Landing
TD - Touch Down
WONG - Weight on Nose Gear
WOW - Weight on Wheels (main gear)
XDUCER- Transducer

APPENDIX B

DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.1 Definitions

Definitions contained in NSTS 22206, Instructions For Preparation of FMEA/CIL, 10 October 1986, were used with the following amplifications and additions.

INTACT ABORT DEFINITIONS:

RTLS - begins at transition to OPS 6 and ends at transition to OPS 9, post-flight

TAL - begins at declaration of the abort and ends at transition to OPS 9, post-flight

AOA - begins at declaration of the abort and ends at transition to OPS 9, post-flight

ATO - begins at declaration of the abort and ends at transition to OPS 9, post-flight

CREDIBLE (CAUSE) - an event that can be predicted or expected in anticipated operational environmental conditions. Excludes an event where multiple failures must first occur to result in environmental extremes

CONTINGENCY CREW PROCEDURES - procedures that are utilized beyond the standard malfunction procedures, pocket checklists, and cue cards

EARLY MISSION TERMINATION - termination of onorbit phase prior to planned end of mission

EFFECTS/RATIONALE - description of the case which generated the highest criticality

HIGHEST CRITICALITY - the highest functional criticality determined in the phase-by-phase analysis

MAJOR MODE (MM) - major sub-mode of software operational sequence (OPS)

MC - Memory Configuration of Primary Avionics Software System (PASS)

MISSION - assigned performance of a specific Orbiter flight with payload/objective accomplishments including orbit phasing and altitude (excludes secondary payloads such as GAS cans, middeck P/L, etc.)

MULTIPLE ORDER FAILURE - describes the failure due to a single cause or event of all units which perform a necessary (critical) function

OFF-NOMINAL CREW PROCEDURES - procedures that are utilized beyond the standard malfunction procedures, pocket checklists, and cue cards

OPS - software operational sequence

PRIMARY MISSION OBJECTIVES - worst case primary mission objectives are equal to mission objectives

PHASE DEFINITIONS:

PRELAUNCH PHASE - begins at launch count-down Orbiter power-up and ends at moding to OPS Major Mode 102 (liftoff)

LIFTOFF MISSION PHASE - begins at SRB ignition (MM 102) and ends at transition out of OPS 1 (Synonymous with ASCENT)

ONORBIT PHASE - begins at transition to OPS 2 or OPS 8 and ends at transition out of OPS 2 or OPS 8

DEORBIT PHASE - begins at transition to OPS Major Mode 301 and ends at first main landing gear touchdown

LANDING/SAFING PHASE - begins at first main gear touchdown and ends with the completion of post-landing safing operations

APPENDIX B
DEFINITIONS, GROUND RULES, AND ASSUMPTIONS

B.2 IOA Project Level Ground Rules and Assumptions

The philosophy embodied in NSTS 22206, Instructions for Preparation of FMEA/CIL, 10 October 1986, was employed with the following amplifications and additions.

1. The operational flight software is an accurate implementation of the Flight System Software Requirements (FSSRs).

   RATIONALE: Software verification is out-of-scope of this task.

2. After liftoff, any parameter which is monitored by system management (SM) or which drives any part of the Caution and Warning System (C&W) will support passage of Redundancy Screen B for its corresponding hardware item.

   RATIONALE: Analysis of on-board parameter availability and/or the actual monitoring by the crew is beyond the scope of this task.

3. Any data employed with flight software is assumed to be functional for the specific vehicle and specific mission being flown.

   RATIONALE: Mission data verification is out-of-scope of this task.

4. All hardware (including firmware) is manufactured and assembled to the design specifications/drawings.

   RATIONALE: Acceptance and verification testing is designed to detect and identify problems before the item is approved for use.

5. All Flight Data File crew procedures will be assumed performed as written, and will not include human error in their performance.

   RATIONALE: Failures caused by human operational error are out-of-scope of this task.

6. All hardware analyses will, as a minimum, be performed at the level of analysis existent within NASA/Prime Contractor Orbiter FMEA/CILs, and will be permitted to go to greater hardware detail levels but not lesser.

RATIONALE: Comparison of IOA analysis results with other analyses requires that both analyses be performed to a comparable level of detail.

7. Verification that a telemetry parameter is actually monitored during AOS by ground-based personnel is not required.

RATIONALE: Analysis of mission-dependent telemetry availability and/or the actual monitoring of applicable data by ground-based personnel is beyond the scope of this task.

8. The determination of criticalities per phase is based on the worst case effect of a failure for the phase being analyzed. The failure can occur in the phase being analyzed or in any previous phase, whichever produces the worst case effects for the phase of interest.

RATIONALE: Assigning phase criticalities ensures a thorough and complete analysis.

9. Analysis of wire harnesses, cables and electrical connectors to determine if FMEAs are warranted will not be performed nor FMEAs assessed.

RATIONALE: Analysis was substantially complete prior to NSTS 22206 ground rule redirection.

10. Analysis of welds or brazed joints that cannot be inspected will not be performed nor FMEAs assessed.

RATIONALE: Analysis was substantially complete prior to NSTS 22206 ground rule redirection.

11. Emergency system or hardware will include burst discs and will exclude the EMU Secondary Oxygen Pack (SOP), pressure relief valves and the landing gear pyrotechnics.

RATIONALE: Clarify definition of emergency systems to ensure consistency throughout IOA project.

B.3 NWS-Specific Ground Rules and Assumptions

1. The GPC (CSS) mode of NWS will be considered the primary mode of directional control for the Orbiter Vehicle following NGTD during landing rollout.

   RATIONALE: This is the flight rule since the Phase II upgrade of NWS which has flown on 61-A, 61-C and 51-L.

2. The GPC (CSS) mode of NWS will be active (HOT) for all landing sites and all landings: EOM and INTACT ABORTS.

   RATIONALE: This is the flight rule since the Phase II upgrade of NWS which has flown on 61-A, 61-C and 51-L.

3. The Flight Rules will restrict landing conditions (weather, landing surface, and crosswinds) such that the brake energy and rollout margins will fall within their assigned limits when differential braking is used as the primary mode of directional control following NGTD during landing rollout.

   RATIONALE: The NWS system is presently fail safe at best with several single point failure points. Differential braking must be a capable backup system to NWS for directional control of the vehicle during landing rollout until the Phase III upgrade of NWS is completed.

4. Differential braking will be considered an unlike, redundant backup system to NWS for directional control of the Orbiter Vehicle during landing rollout following NGTD.

   RATIONALE: Differential braking applies differential forces to the main gear tires in order to steer the Orbiter but NWS uses an actuator system to turn the nose wheel and steer the vehicle. Current flight rules restrict landings to those conditions that allow a safe rollout using differential braking for directional control.

5. The DIRECT (MANUAL) mode of NWS will be considered a like, redundant backup system to the GPC (CSS) mode of NWS for directional control of the Orbiter Vehicle following NGTD during landing rollout.

   RATIONALE: Both systems use MAIN BUS A power, the rudder pedals, the NWS Control Box, the NWS Actuator, and the nose wheel for directional control of the Orbiter Vehicle.

6. The GPC (AUTO) mode of NWS will not be considered a redundant system to the GPC (CSS) mode of NWS for directional control of the Orbiter Vehicle during landing rollout.

   RATIONALE: The GPC (AUTO) mode of NWS requires an active Microwave Scanning Beam Landing System (MSBLS) which is not available at all runways/landing sites. The crew does not train using this control mode.

7. The crew will respond to the annunciation of the NWS fail light by manually moving the NWS toggle switch to the OFF position.

   RATIONALE: MOD recommended crew procedures dictate that the NWS switch be toggled to OFF when the NWS fail light annunciates; however, the DIRECT mode of NWS may then be selected if conditions warrant the risk.

8. For purposes of determining the functional criticality of an item, the total loss of the NWS Actuator Assembly shimmy damping capability shall result in the possible loss of life/vehicle.

   RATIONALE: Although the co-rotating nose wheels have a stabilizing effect; sufficient test data is not available to determine that the total loss of the nose wheel shimmy damping capability is not life threatening.

9. For purposes of passing Redundancy Screen B, the term "Readily Detectable" shall be satisfied by the pilot's ability to see the lack of Orbiter response to NWS inputs during landing rollout.

   RATIONALE: One of the pilot's primary tasks during landing rollout has been to keep the Orbiter Vehicle on the runway centerline. A loss of NWS response during rollout is almost immediately recognizable by the pilot following a rudder pedal input. Corrective action in the form of differential braking is immediately available.

APPENDIX C
DETAILED ANALYSIS

This section contains the IOA analysis worksheets generated during the analysis of this subsystem. The information on these worksheets is intentionally similar to the NASA FMEAs. Each of these sheets identifies the hardware item being analyzed, and parent assembly, as well as the function. For each failure mode, the possible causes are outlined, and the assessed hardware and functional criticality for each mission phase is listed, as described in the NSTS 22206, Instructions for Preparation of FMEA and CIL, 10 October 1986. Finally, effects are entered at the bottom of each sheet, and the worst case criticality is entered at the top.

LEGEND FOR IOA ANALYSIS WORKSHEETS

Hardware Criticalities:

- 1 = Loss of life or vehicle
- 2 = Loss of mission or next failure of any redundant item (like or unlike) could cause loss of life/vehicle
- 3 = All others

Functional Criticalities:

- 1R = Redundant hardware items (like or unlike) all of which, if failed, could cause loss of life or vehicle.
- 2R = Redundant hardware items (like or unlike) all of which, if failed, could cause loss of mission.

Redundancy Screen A:

- 1 = Is Checked Out PreFlight
- 2 = Is Capable of Check Out PreFlight
- 3 = Not Capable of Check Out PreFlight
- NA = Not Applicable

Redundancy Screens B and C:

- P = Passed Screen
- F = Failed Screen
- NA = Not Applicable

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 1/1
MDAC ID: 101 ABORT: 1/1

ITEM: PEDALS, RUDDER
FAILURE MODE: JAMMED (NO TRANSLATIONAL MOVEMENT)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) RUDDER PEDALS (2 SETS-MECHANICALLY LINKED)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	1/1
LIFTOFF:	/NA	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	1/1		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AREA 30 (FLIGHT DECK)
PART NUMBER:

CAUSES: CONTAMINATION (LOOSE DEBRIS), PC PART FAILURE (BENT/BROKEN RODS)

EFFECTS/RATIONALE:
THE RUDDER PEDALS PROVIDE A MECHANICAL LINKAGE TO THE RPTAs, THE COMMAND TRANSDUCER, AND THE BRAKE TRANSDUCERS. THE RPTAs OUTPUT CONTROL SIGNALS FOR THE RUDDER AND NWS.
BEFORE NGTD (CRIT 1/1): FAILING THE RUDDER PEDALS JAMMED WILL RESULT IN THE LOSS OF THE ONLY DIRECTIONAL CONTROL USED BETWEEN MAIN GEAR TOUCHDOWN AND NOSE GEAR TOUCHDOWN. THE LOSS OF DIRECTIONAL CONTROL WOULD RESULT IN THE POSSIBLE LOSS OF CREW/VEHICLE.
AFTER NGTD (CRIT 2/1R): THIS FAILURE WILL NOT AUTOMATICALLY DOWNMODE NWS. THE CREW MUST MANUALLY DOWNMODE NWS BY TOGGLING THE NWS SWITCH TO OFF. DIFFERENTIAL BRAKING IS THE ONLY MODE AVAILABLE TO STEER THE VEHICLE AFTER NGTD.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 102

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: PEDALS, RUDDER
FAILURE MODE: LOSS OF LINKAGE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) RUDDER PEDALS (2 SETS-MECHANICALLY LINKED)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AREA 30 (FLIGHT DECK)
PART NUMBER: :

CAUSES: VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
THE RUDDER PEDALS PROVIDE A MECHANICAL LINKAGE TO THE RPTAs AND THE COMMAND TRANSDUCER FOR NWS AND TO THE BRAKE TRANSDUCERS FOR DIFFERENTIAL BRAKING. LOSS OF ONE RPTA LINKAGE HAS NO EFFECT-THERE IS A SECOND RPTA. LOSS OF A SINGLE BRAKE TRANSDUCER LINKAGE DOES NOT INHIBIT DIFFERENTIAL BRAKING BECAUSE THERE ARE FOUR BRAKE TRANSDUCERS; THE PILOT CAN ASSUME THE BRAKING TASK.
THE LOSS OF THE COMMAND TRANSDUCER LINKAGE WILL TRIP THE BROKEN LINKAGE DETECTOR IN THE NWS CONTROL BOX, AUTOMATICALLY DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 103

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: TRANSDUCER, COMMAND
FAILURE MODE: NO OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) COMMAND TRANSDUCER
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 30V51A21; FLIGHT DECK
PART NUMBER: MC621-0058-0014

CAUSES: VIBRATION, MECHANICAL SHOCK, LOSS OF MECHANICAL LINKAGE (SEPARATED COIL), ELECTRICAL OPEN

EFFECTS/RATIONALE:
THE COMMAND TRANSDUCER SENDS THE STEERING SIGNALS TO THE NWS CONTROL BOX WHEN NWS IS IN THE DIRECT (BACKUP) MODE. IF THE COMMAND TRANSDUCER FAILS, THE DIRECT MODE WILL NO LONGER BE AVAILABLE. IF THE FAILURE IS A TRANSDUCER OPEN/SHORT OR BROKEN LINKAGE DETECTED BY THE NWS CONTROL BOX, NWS WILL AUTOMATICALLY DOWNMODE TO FREE CASTOR AND THE NWS FAIL LIGHT WILL ANNUNCIATE. THESE TWO TYPES OF COMMAND TRANSDUCER FAILURES WILL RESULT IN THE DOWNMODING OF BOTH THE GPC AND DIRECT MODES OF NWS. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 104

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: TRANSDUCER, COMMAND
FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) COMMAND TRANSDUCER
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 30V51A21; FLIGHT DECK
PART NUMBER: MC621-0058-0014

CAUSES: VIBRATION, MECHANICAL SHOCK, DEFORMED COIL, ELECTRICAL SHORT

EFFECTS/RATIONALE:
THE COMMAND TRANSDUCER SENDS THE STEERING SIGNALS TO THE NWS CONTROL BOX WHEN NWS IS IN THE DIRECT (BACKUP) MODE. IF THE COMMAND TRANSDUCER FAILS, THE DIRECT MODE WILL NO LONGER BE AVAILABLE. IF THE FAILURE IS A TRANSDUCER OPEN/SHORT OR BROKEN LINKAGE DETECTED BY THE NWS CONTROL BOX, NWS WILL AUTOMATICALLY DOWNMODE TO FREE CASTOR AND THE NWS FAIL LIGHT WILL ANNUNCIATE. THESE TWO TYPES OF COMMAND TRANSDUCER FAILURES WILL RESULT IN THE DOWNMODING OF BOTH THE GPC AND DIRECT MODES OF NWS.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 105 ABORT: 3/1R

ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA)
FAILURE MODE: SINGLE CHANNEL NO OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) RUDDER PEDAL TRANSDUCER ASSEMBLY (RPTA) (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 30V73A14(COMMANDER), A15(PILOT); FLIGHT DECK
PART NUMBER: MC621-0043-3440

CAUSES: VIBRATION, MECHANICAL SHOCK, LOSS OF MECHANICAL LINKAGE (SEPARATED COIL), ELECTRICAL OPEN

EFFECTS/RATIONALE:
THE RPTAs SEND SIGNALS TO THE RPTA SOP THAT ARE USED FOR STEERING WHEN NWS IS OPERATING IN THE NOMINAL GPC (CSS) MODE. THERE ARE TWO RPTAs MECHANICALLY LINKED TO THE RUDDER PEDALS AND EACH HAS THREE TRANSDUCER CHANNELS.
FAILURE OF ALL REDUNDANCY RESULTS IN THE LOSS OF RUDDER (CSS) CONTROL WHICH IS CRITICAL TO DIRECTIONAL CONTROL DURING MAIN GEAR ROLLOUT BEFORE NGTD. THE LOSS OF DIRECTIONAL CONTROL WOULD RESULT IN THE POSSIBLE LOSS OF CREW/VEHICLE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.
THE AUTO MODE OF NWS IS STILL AVAILABLE IF A MSBLS IS AVAILABLE.

REFERENCES: GN&C 301 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 106 ABORT: 3/1R

ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA)
FAILURE MODE: SINGLE CHANNEL ERRONEOUS OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) RUDDER PEDAL TRANSDUCER ASSEMBLY (RPTA) (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 30V73A14(COMMANDER), A15(PILOT); FLIGHT DECK
PART NUMBER: MC621-0043-3440

CAUSES: VIBRATION, MECHANICAL SHOCK, DEFORMED COIL, ELECTRICAL SHORT

EFFECTS/RATIONALE:
THE RPTAs SEND SIGNALS TO THE RPTA SOP THAT ARE USED FOR STEERING WHEN NWS IS OPERATING IN THE NOMINAL GPC (CSS) MODE. THERE ARE TWO RPTAs MECHANICALLY LINKED TO THE RUDDER PEDALS AND EACH HAS THREE TRANSDUCER CHANNELS.
FAILURE OF ALL REDUNDANCY RESULTS IN THE LOSS OF RUDDER (CSS) CONTROL WHICH IS CRITICAL TO DIRECTIONAL CONTROL DURING MAIN GEAR ROLLOUT BEFORE NGTD. THE LOSS OF DIRECTIONAL CONTROL WOULD RESULT IN THE POSSIBLE LOSS OF CREW/VEHICLE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.
THE AUTO MODE OF NWS IS STILL AVAILABLE IF A MSBLS IS AVAILABLE.

REFERENCES: GN&C 302 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 107 ABORT: 2/1R

ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA)
FAILURE MODE: LOSS OF RPTA OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) RUDDER PEDAL TRANSDUCER ASSEMBLY (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 30V731A14(COMMANDER), A15(PILOT); FLIGHT DECK
PART NUMBER: MC621-0043-3440

CAUSES: LOSS OF LINKAGE

EFFECTS/RATIONALE:
THE RPTA SENDS NWS AND RUDDER SIGNALS TO THE GPC. THERE ARE TWO RPTAs MECHANICALLY LINKED TO THE RUDDER PEDALS.
BEFORE NGTD (CRIT 2/1R): FAILURE OF A SECOND RPTA RESULTS IN THE LOSS OF RUDDER (CSS) CONTROL WHICH IS CRITICAL TO DIRECTIONAL CONTROL DURING MAIN GEAR ROLLOUT BEFORE NGTD. THE LOSS OF DIRECTIONAL CONTROL WOULD RESULT IN THE POSSIBLE LOSS OF CREW/VEHICLE.
AFTER NGTD (CRIT 3/1R): FAILURE OF A SECOND RPTA WOULD RESULT IN THE LOSS OF THE GPC (CSS) MODE OF NWS.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS NOT AVAILABLE. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.
THE AUTO MODE OF GPC NWS IS STILL AVAILABLE IF A MSBLS IS AVAILABLE.

REFERENCES: GN&C 304 (CRIT 2/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 108 ABORT: 2/1R

ITEM: TRANSDUCER, RUDDER PEDAL ASSEMBLY (RPTA)
FAILURE MODE: ERRONEOUS OUTPUT OF RPTA

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) RUDDER PEDAL ASSEMBLIES
3) RUDDER PEDAL TRANSDUCER ASSEMBLY (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	2/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 30V731A14(COMMANDER), A15(PILOT); FLIGHT DECK
PART NUMBER: MC621-0043-3440

CAUSES: VIBRATION, MECHANICAL SHOCK, SHORT COIL TO COIL

EFFECTS/RATIONALE:
THE RPTA SENDS NWS AND RUDDER SIGNALS TO THE GPC. THERE ARE TWO RPTAs MECHANICALLY LINKED TO THE RUDDER PEDALS.
BEFORE NGTD (CRIT 2/1R): FAILURE OF A SECOND RPTA RESULTS IN THE LOSS OF RUDDER (CSS) CONTROL WHICH IS CRITICAL TO DIRECTIONAL CONTROL DURING MAIN GEAR ROLLOUT BEFORE NGTD. THE LOSS OF DIRECTIONAL CONTROL WOULD RESULT IN THE POSSIBLE LOSS OF CREW/VEHICLE.
AFTER NGTD (CRIT 3/1R): FAILURE OF A SECOND RPTA WOULD RESULT IN THE LOSS OF THE GPC (CSS) MODF OF NWS.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS NOT AVAILABLE. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.
THE AUTO MODE OF GPC NWS IS STILL AVAILABLE IF A MSBLS IS AVAILABLE.

REFERENCES: GN&C 304 (CRIT 2/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 201

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: BOX, NWS CONTROL - FAILURE DETECTION CIRCUITRY
FAILURE MODE: FAILS ON

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) STEERING CONTROL BOX
3) FAILURE DETECTION CIRCUITRY: FAULT DETECTORS (5)/FAIL DETECTOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A16; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0015

CAUSES: VIBRATION, MECHANICAL SHOCK, ELECTRICAL/RESISTOR SHORT

EFFECTS/RATIONALE:
IF ANY OF THE FIVE FAULT DETECTOR FAILS ON, THE FAIL DETECTOR WILL LATCH ON. FAILURE ON WILL RESULT IN AN AUTOMATIC DOWNMODE OF NWS TO THE FREE CASTOR MODE AND THE ANNUNCIATION OF THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 202 ABORT: 3/3

ITEM: BOX, NWS CONTROL - FAILURE DETECTION CIRCUITRY
FAILURE MODE: FAILS OFF

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) STEERING CONTROL BOX
3) FAILURE DETECTION CIRCUITRY: FAULT DETECTORS (5)/FAIL DETECTOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A16; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0015

CAUSES: VIBRATION, MECHANICAL SHOCK, ELECTRICAL/RESISTOR OPEN

EFFECTS/RATIONALE:
THE TRIPLE CHANNEL WRAPAROUND FEEDBACK TRANSDUCER LOGIC PROVIDES PROTECTION IN THE NORMAL GPC MODE OF OPERATION. THE FAILING OFF OF THE CONTROL BOX LOGIC HAS NO EFFECT ON THE NORMAL OPERATING MODE OF NWS.
FAILING OFF OF THE CONTROL LOGIC IN THE DIRECT MODE OF NWS RESULTS IN THE LOSS OF ONE OR MORE OF THE FIVE NON-REDUNDANT DETECTOR TYPES.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 203 ABORT: 3/3

ITEM: BOX, STEERING CONTROL - PILOT VALVE CONTROL CIRCUIT
FAILURE MODE: FAILS SHORTED (PROVIDES A PREMATURE GROUND)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) STEERING CONTROL BOX
3) PILOT VALVE CONTROL CIRCUIT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A16; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0015

CAUSES: VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE PILOT VALVE CONTROL CIRCUITS ACTIVATE OR DEACTIVATE THE NWS ACTUATOR PILOT VALVES BY RESPECTIVELY PROVIDING OR REMOVING GROUNDS TO THE PILOT VALVE SOLENOIDS' POWER SOURCE. IF ONE OF THE CIRCUITS FAILS CLOSED, ONE OF THE PILOT VALVES IS PREMATURELY ACTIVATED (OPENED). THERE IS NO EFFECT ON NWS BECAUSE THE SECOND PILOT VALVE PREVENTS HYDRAULIC ACTIVATION OF THE ACTUATOR UNTIL NWS ACTIVATION.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 204 ABORT: 2/1R

ITEM: BOX, STEERING CONTROL - PILOT VALVE CONTROL CIRCUIT
FAILURE MODE: FAILS OPEN (FAILS TO PROVIDE A GROUND)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) STEERING CONTROL BOX
3) PILOT VALVE CONTROL CIRCUIT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A16; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0015

CAUSES: VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE PILOT VALVE CONTROL CIRCUITS ACTIVATE OR DEACTIVATE THE NWS ACTUATOR PILOT VALVES BY RESPECTIVELY PROVIDING OR REMOVING GROUNDS TO THE PILOT VALVE SOLENOIDS' POWER SOURCE. IF ONE OF THE CIRCUITS FAILS OPEN, A GROUND IS NOT PROVIDED TO ONE OF THE ACTIVATION SOLENOIDS, ITS ASSOCIATED PILOT VALVE WILL CLOSE, NWS WILL AUTOMATICALLY DOWNMODE TO FREE CASTOR MODE AND THE NWS FAIL LIGHT WILL ANNUNCIATE.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 205

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: BOX, STEERING CONTROL - STEERING SIGNAL OUTPUT
FAILURE MODE: LOSS OF OR PARTIAL OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) STEERING CONTROL BOX
3) STEERING SIGNAL OUTPUT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A16; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0015

CAUSES: VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE, ELECTRICAL OPEN

EFFECTS/RATIONALE:
THE NWS CONTROL BOX PERFORMS THE FINAL PROCESSING OF THE NWS SIGNALS. THE LOSS OF OUTPUT WOULD RESULT IN A MISCOMPARE BETWEEN THE COMMANDED POSITION AND THE FEEDBACK POSITION, RESULTING IN AN AUTOMATIC DOWNMODE TO FREE CASTOR MODE AND THE ANNUNCIATION OF THE FAIL LIGHT.
THE DIRECT MODE OF NWS WOULD ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 206 ABORT: 2/1R

ITEM: BOX, STEERING CONTROL - STEERING SIGNAL OUTPUT
FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) STEERING CONTROL BOX
3) STEERING SIGNAL OUTPUT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A16; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0015

CAUSES: IMPROPER INPUT SIGNAL, VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE, ELECTRICAL CLOSE

EFFECTS/RATIONALE:
THE NWS CONTROL BOX PERFORMS THE FINAL PROCESSING OF THE NWS SIGNALS. THE LOSS OF OUTPUT WOULD RESULT IN A MISCOMPARE BETWEEN THE COMMANDED POSITION AND THE FEEDBACK POSITION, RESULTING IN AN AUTOMATIC DOWNMODE TO FREE CASTOR MODE AND THE ANNUNCIATION OF THE FAIL LIGHT.
THE DIRECT MODE OF NWS WOULD ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 301

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: ACCUMULATOR/COMPENSATOR
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) COMPENSATOR/ACCUMULATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/1R
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, PIECE PART FAILURE (POPPET)

EFFECTS/RATIONALE:
THE PURPOSE OF THE ACCUMULATOR IS TO MAINTAIN A CONSTANT BACKPRESSURE ON THE STEERING DAMPING SYSTEM TO PREVENT CAVITATION OF THE STEERING ACTUATOR DURING FREE CASTOR DAMPING. FAILING THE ACCUMULATOR OPEN HAS NO EFFECT AS OPEN IS THE NORMAL OPERATING POSITION FOR THE ACCUMULATOR DURING NWS.
FAILING THE ACCUMULATOR OPEN DURING FREE CASTOR (DAMPING MODE) RESULTS IN THE CAVITATION OF THE ACTUATOR, THE TOTAL LOSS OF THE NWS ACTUATOR SHIMMY DAMPING CAPABILITY,AND THE POSSIBLE LOSS OF THE ORBITER VEHICLE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 302 ABORT: 2/1R

ITEM: ACCUMULATOR/COMPENSATOR
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) COMPENSATOR/ACCUMULATOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, PIECE PART FAILURE (POPPET)

EFFECTS/RATIONALE:
THE PURPOSE OF THE ACCUMULATOR IS TO MAINTAIN A CONSTANT BACKPRESSURE ON THE STEERING DAMPING SYSTEM TO PREVENT CAVITATION OF THE STEERING ACTUATOR DURING FREE CASTOR DAMPING. FAILING THE ACCUMULATOR CLOSED PREVENTS THE RETURN OF FLUID FROM THE ACTUATOR TO HYDRAULIC SYSTEM 1. THE RESULTING PRESSURE BUILDUP WOULD INHIBIT THE ACTUATOR CONTROL OF THE NOSE WHEEL, TRIP A FAULT DETECTION CIRCUIT, DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT.
FAILURE CLOSED DURING FREE CASTOR HAS NO EFFECT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 303

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: AMPLIFIER, STEERING POSITION (SPA)
FAILURE MODE: ERRONEOUS OUTPUT ON ONE CHANNEL

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION AMPLIFIER (SPA)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 80V51A31; AVIONICS BAY No. 2
PART NUMBER: MC621-0043-3641

CAUSES: VIBRATION, MECHANICAL SHOCK, ELECTRICAL SHORT, LOSS OF/IMPROPER INPUT

EFFECTS/RATIONALE:
THE SPA AMPLIFIES NOSE WHEEL POSITION SIGNALS FROM THE SPT AND TRANSMITS THEM TO THE NW POSITION SOP ON THREE REDUNDANT CHANNELS. THE LOSS OF ONE CHANNEL HAS NO EFFECT - RM WILL AVERAGE THE REMAINING VALUES TO PRODUCE GOOD OUTPUT.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 304 ABORT: 3/3

ITEM: AMPLIFIER, STEERING POSITION (SPA)
FAILURE MODE: LOSS OF OUTPUT ON ONE CHANNEL

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION AMPLIFIER (SPA)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 80V51A31; AVIONICS BAY No. 2
PART NUMBER: MC621-0043-3641

CAUSES: VIBRATION, MECHANICAL SHOCK, ELECTRICAL SHORT, LOSS OF/IMPROPER INPUT

EFFECTS/RATIONALE:
THE SPA AMPLIFIES NOSE WHEEL POSITION SIGNALS FROM THE SPT AND TRANSMITS THEM TO THE NW POSITION SOP ON THREE REDUNDANT CHANNELS. THE LOSS OF ONE CHANNEL HAS NO EFFECT - RM WILL AVERAGE THE REMAINING VALUES TO PRODUCE GOOD OUTPUT.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 305

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: AMPLIFIER, STEERING POSITION (SPA)
FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION AMPLIFIER (SPA)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 80V51A31; AVIONICS BAY No. 2
PART NUMBER: MC621-0043-3641

CAUSES: VIBRATION, MECHANICAL SHOCK, ELECTRICAL SHORT, LOSS OF/IMPROPER INPUT

EFFECTS/RATIONALE:
SPA FAILURE RESULTS IN THE LOSS OF WRAPAROUND FEEDBACK PROTECTION IN THE GPC MODE OF NWS. THIS FAILURE LEADS TO A MISCOMPARE BETWEEN COMMAND AND FEEDBACK SIGNALS IN THE NW POSITION SOP. THE SOP WOULD DOWNMODE NWS BY INHIBITING THE ENABLE 1 AND 2 DISCRETES AND ILLUMINATE THE NWS FAIL LIGHT VIA AN MDM FF4 DISCRETE. THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 306

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/1R
ABORT: 3/1R

ITEM: AMPLIFIER, STEERING POSITION (SPA)
FAILURE MODE: LOSS OF OR PARTIAL OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION AMPLIFIER (SPA)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 80V51A31; AVIONICS BAY No. 2
PART NUMBER: MC621-0043-3641

CAUSES: VIBRATION, MECHANICAL SHOCK, ELECTRICAL SHORT, LOSS OF OR IMPROPER INPUT

EFFECTS/RATIONALE:
SPA FAILURE RESULTS IN THE LOSS OF WRAPAROUND FEEDBACK PROTECTION IN THE GPC MODE OF NWS. THIS FAILURE WOULD LEAD TO A MISCOMPARE BETWEEN COMMAND AND FEEDBACK SIGNALS IN THE NW POSITION SOP. THE SOP WOULD DOWNMODE NWS BY INHIBITING THE ENABLE 1 AND 2 DISCRETES AND ILLUMINATE THE NWS FAIL LIGHT VIA AN MDM FF4 DISCRETE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/19/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 1/1
MDAC ID: 307 ABORT: 1/1

ITEM: ASSEMBLY, ACTUATOR - HYDRAULIC HOUSING
FAILURE MODE: RUPTURE/LEAKAGE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) ACTUATOR ASSEMBLY HYDRAULIC HOUSING
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	1/1
LIFTOFF:	/NA	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	1/1		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: MATERIAL FAILURE

EFFECTS/RATIONALE:
A RUPTURE IN THE ACTUATOR HYDRAULIC HOUSING WOULD RESULT IN A LOSS OF PRESSURE IN THE ACTUATOR ASSEMBLY THAT WOULD RESULT IN THE LOSS OF NWS. IF THE RUPTURE CAUSED THE STEERING RESPONSE TO DETERIORATE TO A LEVEL WHERE THE POSITION ERROR EXCEEDED THE SET TOLERANCE LEVEL, THE DETECTION CIRCUITRY WOULD AUTOMATICALLY DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT. DIRECT MODE OF NWS WILL ALSO FAIL.
A RUPTURE CAN ALSO CAUSE A TOTAL LOSS OF THE SHIMMY DAMPING CAPABILITY OF THE ACTUATOR AND RESULT IN THE LOSS OF THE VEHICLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 308

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
ABORT: 1/1

ITEM: PISTON, ACTUATOR ARM
FAILURE MODE: FAILS JAMMED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) ACTUATOR ARM/PISTON
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	1/1
LIFTOFF:	/NA	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	1/1		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, BROKEN/LOSS OF MECHANICAL LINKAGE

EFFECTS/RATIONALE:
THE ACTUATOR PISTON IS A MECHANICAL ARM THAT LINKS THE ACTUATOR TO THE COLLAR OF THE NOSE WHEEL STRUT THAT TURNS THE NOSE WHEEL. IF THE ARM STICKS/JAMS, THE RESULTING POSITION MISCOMPARE WILL TRIP AN ERROR DETECTION LOGIC CIRCUIT, DOWNMODE NWS TO FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT. FAILING THE ACTUATOR PISTON JAMMED MAY NOT BE CONSIDERED A CREDIBLE FAILURE MODE (MANUFACTURER OPINION).
THE DIRECT MODE OF STEERING WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE AND DIFFERENTIAL BRAKING MAY NOT BE EFFECTIVE MODES OF STEERING THE VEHICLE WITH THE ACTUATOR ARM FAILED HARD OVER.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 309

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
ABORT: 1/1

ITEM: PISTON, ACTUATOR ARM
FAILURE MODE: FAILS TO RESPOND (BROKEN LINKAGE)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) ACTUATOR ARM/PISTON
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	1/1
LIFTOFF:	/NA	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	1/1		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
THE ACTUATOR PISTON ARM IS A MECHANICAL ARM THAT LINKS THE ACTUATOR TO THE COLLAR OF THE NOSE WHEEL STRUT THAT TURNS THE NOSE WHEEL. THE LOSS OF THE ARM LINKAGE CAUSES THE LOSS OF NWS AND ALL SHIMMY DAMPING CAPABILITY TO THE NOSE WHEEL RESULTING IN THE POSSIBLE LOSS OF THE VEHICLE.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 310 ABORT: 2/1R

ITEM: FILTER, INLET (SHUTOFF VALVE)
FAILURE MODE: FAILS TO FILTER (FAILS OPEN)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) INLET FILTER (SHUTOFF VALVE)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	2/1R
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [F] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: OVERLOADED, OVERUSED

EFFECTS/RATIONALE:
THE INLET FILTER FILTERS THE HYDRAULIC FLUID ENTERING THE ACTUATOR ASSEMBLY. IF IT FAILS OPEN ALL THE VALVES IN THE ACTUATOR ASSEMBLY ARE SUBJECT TO CONTAMINATION THAT WOULD RESULT IN THE LOSS OF NWS. THE RESULTING CONTAMINATION WOULD ALSO DEGRADE SHIMMY DAMPING IN THE FREE CASTOR MODE.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 311

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: FILTER, INLET (SHUTOFF VALVE)
FAILURE MODE: FAILS CLOSED (BLOCKED)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) INLET FILTER (SHUTOFF VALVE)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: OVERLOADED, OVERUSED

EFFECTS/RATIONALE:
THE INLET FILTER FILTERS THE HYDRAULIC FLUID ENTERING THE ACTUATOR ASSEMBLY. IF IT FAILS CLOSED, THE LOSS OF HYDRAULIC PRESSURE WOULD RESULT IN THE LOSS OF NWS. FAILURE DETECTION CIRCUITRY WILL AUTOMATICALLY DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/19/86
SUBSYSTEM: NWS
MDAC ID: 312

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 1/1
ABORT: 1/1

ITEM: HYDRAULIC SYSTEM - CONNECTORS, HOSE ASSEMBLY
FAILURE MODE: RUPTURE/LEAKAGE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) HYDRAULIC SYSTEM - CONNECTORS, HOSE ASSEMBLY
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	1/1
LIFTOFF:	/NA	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	1/1		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: MATERIAL FAILURE

EFFECTS/RATIONALE:
A RUPTURE IN THE HOSE ASSEMBLY OF THE NWS ACTUATOR ASSEMBLY WOULD RESULT IN A LOSS OF PRESSURE IN THE ASSEMBLY THAT WOULD CAUSE THE LOSS OF NWS. IF THE RUPTURE CAUSED THE STEERING RESPONSE TO DETERIORATE TO A LEVEL WHERE THE POSITION ERROR EXCEEDED THE SET TOLERANCE, THE FAILURE DETECTION CIRCUITRY WOULD AUTOMATICALLY DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT. THE DIRECT MODE OF NWS WILL ALSO FAIL.
A RUPTURE CAN ALSO CAUSE A TOTAL LOSS OF THE SHIMMY DAMPING CAPABILITY OF THE ACTUATOR AND RESULT IN THE LOSS OF THE VEHICLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 313 ABORT: 2/1R

ITEM: HYDRAULIC SYSTEM - CONNECTORS, HOSE ASSEMBLY
FAILURE MODE: FAILS CLOSED (BLOCKED)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) HYDRAULIC SYSTEM - CONNECTORS, HOSE ASSEMBLY
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
A BLOCKED HOSE IN THE NWS ACTUATOR ASSEMBLY WOULD RESULT IN A LOSS OF PRESSURE IN THE ASSEMBLY THAT WOULD CAUSE THE LOSS OF NWS. IF THE BLOCKAGE CAUSED THE STEERING RESPONSE TO DETERIORATE TO A LEVEL WHERE THE POSITION ERROR EXCEEDED THE SET TOLERANCE, THE FAILURE DETECTION CIRCUITRY WOULD AUTOMATICALLY DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT. IF THE HYDRAULIC PRESSURE FIRST FELL NEAR 1000 PSIG, THE PRESSURE SWITCH WOULD OPEN AND ANNUNCIATE THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 314

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: SWITCH, PRESSURE
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) PRESSURE SWITCH
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22S1; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: PIECE PART FAILURE, CONTAMINATION, BINDING

EFFECTS/RATIONALE:
THE PRESSURE SWITCH AFFECTS THE HARDWIRED PATH FOR THE ANNUNCIATION OF THE NWS FAIL SWITCH AND THE NWS ACTIVE DISCRETE THAT IS TRANSMITTED TO THE NOSE WHEEL POSITION SOP. THE FAILED OPEN SWITCH WILL ANNUNCIATE THE FAIL LIGHT AND THE CREW WILL DOWNMODE NWS TO FREE CASTOR.
DIRECT MODE OF NWS WILL STILL BE AVAILABLE BUT THE NWS FAIL LIGHT WILL REMAIN ANNUNCIATED. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 315

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: SWITCH, PRESSURE
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) PRESSURE SWITCH
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A22S1; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: PIECE PART FAILURE, CONTAMINATION, BINDING

EFFECTS/RATIONALE:
THE PRESSURE SWITCH AFFECTS THE HARDWIRED PATH FOR THE ANNUNCIATION OF THE NWS FAIL SWITCH AND THE NWS ACTIVE DISCRETE THAT IS TRANSMITTED TO THE NOSE WHEEL POSITION SOP. THE FAILED CLOSED PRESSURE SWITCH WILL HAVE NO EFFECT ON NWS EXCEPT THE LOSS OF ONE PATH OF FAILURE DETECTION CAPABILITY. GPC WRAPAROUND EARLY FAILURE DETECTION IS STILL ACTIVE. THE DIRECT MODE OF NWS IS STILL AVAILABLE BUT THE PRESSURE SWITCH FAILURE WILL INHIBIT THE ANNUNCIATION OF THE NWS FAIL LIGHT. DETECTION OF A SECOND NWS FAILURE MAY BE AFTER THE FACT, MAKING CORRECTIVE ACTION MORE TIME CRITICAL.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 316

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: TRANSDUCER, FEEDBACK
FAILURE MODE: NO OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) FEEDBACK TRANSDUCER
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22MT1; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: VIBRATION, MECHANICAL SHOCK, LOSS OF MECHANICAL LINKAGE (SEPARATED COIL), ELECTRICAL OPEN

EFFECTS/RATIONALE:
THE FEEDBACK (FB) TRANSDUCER TRANSMITS AN ELECTRICAL SIGNAL TO THE NWS CONTROL BOX WHERE IT IS DIFFERENTIATED TO OBTAIN A VOLTAGE PROPORTIONAL TO THE NOSEGEAR COLLAR ROTATIONAL VELOCITY. FAILURE OF THE FB TRANSDUCER WOULD TRIP THE RATE/DIRECTION AND/OR THE OPEN/SHORT DETECTION CIRCUITS IN THE NWS CONTROL BOX, DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT. THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 317

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: TRANSDUCER, FEEDBACK
FAILURE MODE: ERRONEOUS OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) FEEDBACK TRANSDUCER
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22MT1; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: VIBRATION, MECHANICAL SHOCK, DEFORMED COIL, ELECTRICAL SHORT

EFFECTS/RATIONALE:
THE FEEDBACK (FB) TRANSDUCER TRANSMITS AN ELECTRICAL SIGNAL TO THE NWS CONTROL BOX WHERE IT IS DIFFERENTIATED TO OBTAIN A VOLTAGE PROPORTIONAL TO THE NOSEGEAR COLLAR ROTATIONAL VELOCITY. FAILURE OF THE FB TRANSDUCER WOULD TRIP THE RATE/DIRECTION AND/OR THE OPEN/SHORT DETECTION CIRCUITS IN THE NWS CONTROL BOX, DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT. THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 318

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: TRANSDUCER, STEERING POSITION (SPT)
FAILURE MODE: SINGLE CHANNEL NO OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION TRANSDUCER (SPT)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 81V51A30; NOSE GEAR STRUT
PART NUMBER: MC621-0043-3740

CAUSES: VIBRATION, MECHANICAL SHOCK, LOSS OF MECHANICAL LINKAGE (SEPARATED COIL), ELECTRICAL OPEN

EFFECTS/RATIONALE:
THE STEERING POSITION TRANSDUCER SENDS NOSE WHEEL POSITION SIGNALS TO THE STEERING POSITION AMPLIFIER USING THREE REDUNDANT TRANSDUCERS. FAILING ONE TRANSDUCER CHANNEL HAS NO EFFECT (RM WILL AVERAGE THE REMAINING TWO SIGNALS TO PRODUCE GOOD OUTPUT). DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 319 ABORT: 3/3

ITEM: TRANSDUCER, STEERING POSITION (SPT)
FAILURE MODE: SINGLE CHANNEL ERRONEOUS OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION TRANSDUCER (SPT)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 81V51A30; NOSE GEAR STRUT
PART NUMBER: MC621-0043-3740

CAUSES: VIBRATION, MECHANICAL SHOCK, DEFORMED COIL, ELECTRICAL SHORT

EFFECTS/RATIONALE:
THE STEERING POSITION TRANSDUCER SENDS NOSE WHEEL POSITION SIGNALS TO THE STEERING POSITION AMPLIFIER USING THREE REDUNDANT TRANSDUCERS. FAILING ONE TRANSDUCER CHANNEL HAS NO EFFECT (RM WILL AVERAGE THE REMAINING TWO SIGNALS TO PRODUCE GOOD OUTPUT). DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 320 ABORT: 3/1R

ITEM: TRANSDUCER, STEERING POSITION (SPT)
FAILURE MODE: LOSS OF SPT OUTPUT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION TRANSDUCER (SPT)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V51A30; NOSE GEAR STRUT
PART NUMBER: MC621-0043-3740

CAUSES: LOSS OF MECHANICAL LINKAGE

EFFECTS/RATIONALE:
THE STEERING POSITION TRANSDUCER (SPT) SENDS NOSE WHEEL POSITION SIGNALS TO THE STEERING POSITION AMPLIFIER USING THREE REDUNDANT TRANSDUCERS. FAILURE OF THE SPT WILL CAUSE A MISCOMPARE IN THE NOSE WHEEL POSITION SOP; DOWNMODE NWS TO FREE CASTOR BY INHIBITING NWS ENABLE 1,2 DISCRETES; AND ANNUNCIATE THE NWS FAIL LIGHT VIA AN MDM FF4 DISCRETE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 321 ABORT: 3/1R

ITEM: TRANSDUCER, STEERING POSITION (SPT)
FAILURE MODE: ERRONEOUS OUTPUT OF THE SPT

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) STEERING POSITION TRANSDUCER (SPT)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V51A30; NOSE GEAR STRUT
PART NUMBER: MC621-0043-3740

CAUSES: SHORTS COIL TO COIL (VIBRATION, MECHANICAL SHOCK)

EFFECTS/RATIONALE:
THE STEERING POSITION TRANSDUCER (SPT) SENDS NOSE WHEEL POSITION SIGNALS TO THE STEERING POSITION AMPLIFIER USING THREE REDUNDANT TRANSDUCERS. FAILURE OF THE SPT WILL CAUSE A MISCOMPARE IN THE NOSE WHEEL POSITION SOP; DOWNMODE NWS TO FREE CASTOR BY INHIBITING NWS ENABLE 1,2 DISCRETES; AND ANNUNCIATE THE NWS FAIL LIGHT VIA AN MDM FF4 DISCRETE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 322

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: VALVE, ANTI-CAVITATION CHECK
FAILURE MODE: FAILS OPEN/LEAKAGE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) ANTI-CAVITATION CHECK VALVE (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [2] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
THE ANTI-CAVITATION VALVES(2) ARE FREE FLOATING BALL VALVES THAT PREVENT CAVITATION OF THE ACTUATOR DURING FREE CASTOR AND PREVENT HIGH PRESSURE FLUID FROM ENTERING THE RETURN LINE PREMATURELY. IF THE VALVES FAIL OPEN, THE RESULT WILL BE A DEGREDATION IN TURNING RESPONSE. IF THE NOSE WHEEL POSITION ERROR EXCEEDS THE SET TOLERANCE, THE DETECTION LOGIC WILL AUTOMATICALLY DOWNMODE NWS TO FREE CASTOR AND ANNUNCIATE THE NWS FAIL LIGHT.
FAILURE OPEN DURING FREE CASTOR HAS NO EFFECT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 323 ABORT: 3/3

ITEM: VALVE, ANTI-CAVITATION CHECK
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) ANTI-CAVITATION CHECK VALVE (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, WATER HAMMER

EFFECTS/RATIONALE:
THE ANTI-CAVITATION VALVES(2) ARE FREE FLOATING BALL VALVES THAT PREVENT CAVITATION OF THE ACTUATOR DURING FREE CASTOR AND PREVENT HIGH PRESSURE FLUID FROM ENTERING THE RETURN LINE PREMATURELY. IF THE VALVES FAIL CLOSED, THERE IS NO EFFECT ON NWS AS CLOSED IS THE NORMAL OPERATING MODE FOR THE VALVES DURING NWS.
FAILED CLOSED DURING FREE CASTOR WOULD RESULT IN A DEGREDATION IN SHIMMY DAMPING.
FAILING CLOSED MAY NOT BE CONSIDERED A CREDIBLE FAILURE MODE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 324 ABORT: 2/1R

ITEM: VALVE, E-H SERVO
FAILURE MODE: FAILS TO RESPOND/OPERATE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTUATOR ASSEMBLY
3) ELECTRO-HYDRAULIC SERVO VALVE: PILOT VALVE/SHUTTLE VALVE/CONTROL COILS
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22LV3; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: VIBRATION, MECHANICAL SHOCK, OPEN CONTROL COIL, LOSS OF CONTROL SIGNAL, CONTAMINATION

EFFECTS/RATIONALE:
THE E-H VALVE METERS FLUID TO THE ACTUATOR PISTON BALANCE AREA IN RESPONSE TO ELECTRICAL SIGNALS FROM THE NWS CONTROL BOX. IF THE E-H VALVE FAILS, THE NOSE WHEEL WILL EITHER FAIL TO MOVE, OPERATE ERRATICALLY, OR FAIL HARD OVER. THE CONTROL BOX FAILURE DETECTION LOGIC OR THE NOSE WHEEL POSITION SOP WILL DETECT THE FAILURE, DOWNMODE TO FREE CASTOR, AND ANNUNCIATE THE NWS FAIL LIGHT. DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 325 ABORT: 2/1R

ITEM: VALVE, E-H SERVO
FAILURE MODE: ERRATIC RESPONSE/INADVERTANT OPERATION

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTUATOR ASSEMBLY
3) ELECTRO-HYDRAULIC SERVO VALVE: PILOT VALVE/SHUTTLE VALVE/CONTROL COILS
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22LV3; NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: VIBRATION, MECHANICAL SHOCK, DEFORMED/SHORTED COIL, INADVERTANT INPUT SIGNAL, CONTAMINATION

EFFECTS/RATIONALE:
THE E-H VALVE METERS FLUID TO THE ACTUATOR PISTON BALANCE AREA IN RESPONSE TO ELECTRICAL SIGNALS FROM THE NWS CONTROL BOX. IF THE E-H VALVE FAILS, THE NOSE WHEEL WILL EITHER FAIL TO MOVE, OPERATE ERRATICALLY, OR FAIL HARD OVER. THE CONTROL BOX FAILURE DETECTION LOGIC OR THE NOSE WHEEL POSITION SOP WILL DETECT THE FAILURE, DOWNMODE TO FREE CASTOR, AND ANNUNCIATE THE NWS FAIL LIGHT. DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 326 ABORT: 2/1R

ITEM: VALVE, E-H PROTECTION CHECK (RETURN LINE ISOLATION)
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) E-H PROTECTION CHECK VALVE (RETURN LINE ISOLATION VALVE)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, PIECE PART FAILURE (SPRING)

EFFECTS/RATIONALE:
THE E-H PROTECTION VALVE IS A BALL/SPRING VALVE THAT PREVENTS REVERSE FLOW IN THE RETURN LINE FROM THE ACCUMULATOR TO THE E-H SERVO VALVE. IF THE VALVE FAILS OPEN DURING NWS THERE IS NO EFFECT. OPEN IS THE NORMAL OPERATING MODE FOR THE VALVE DURING NWS.
IF THE VALVE FAILS PRIOR TO LANDING GEAR DEPLOY, HIGH PRESSURE BUILDUP DURING LANDING GEAR DEPLOY COULD DAMAGE THE SERVO VALVE FIRST STAGE WHICH WOULD RESULT IN THE LOSS OF NWS DURING ROLLOUT. FAILURE OPEN DURING FREE CASTOR, THERE IS SOME DEGREDATION OF SHIMMY DAMPING CAPABILITY.
THE DIRECT MODE OF NWS WILL ALSO FAIL IF THE E-H VALVE IS DAMAGED. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING CAN BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.
REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 327 ABORT: 2/1R

ITEM: VALVE, E-H PROTECTION CHECK (RETURN LINE ISOLATION)
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) E-H PROTECTION CHECK VALVE (RETURN LINE ISOLATION VALVE)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, PIECE PART FAILURE (SPRING)

EFFECTS/RATIONALE:
THE E-H PROTECTION VALVE IS A BALL/SPRING VALVE THAT PREVENTS REVERSE FLOW IN THE RETURN LINE FROM THE ACCUMULATOR TO THE E-H SERVO VALVE. IF THE VALVE FAILS CLOSED DURING NWS, THE RESULTING BUILUP OF PRESSURE IN THE RETURN LINE WOULD INHIBIT STEERING RESPONSE AND TRIP AN ERROR DETECTION CIRCUIT, AUTOMATICALLY DOWNMODING NWS TO FREE CASTOR AND ANNUNCIATING THE NWS FAIL LIGHT.
FAILURE CLOSED DURING FREE CASTOR HAS NO EFFECT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 328 ABORT: 2/1R

ITEM: VALVE, OVERLOAD CHECK (2 OF)
FAILURE MODE: FAILS OPEN/LEAKAGE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) OVERLOAD CHECK VALVES (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/1R	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION

EFFECTS/RATIONALE:
THE OVERLOAD CHECK VALVES ARE FREE FLOATING BALL VALVES THAT RELIEVE EXCESSIVE PRESSURE BUILDUP ON THE OPERATIONAL SIDE OF THE ACTUATOR ASSEMBLY. THESE TWO NONREDUNDANT VALVES EACH PROTECT A SEPARATE LINE. IF THE VALVE FAILS OPEN DURING NWS, THE SUPPLY PRESSURE WOULD HAVE A DIRECT PATH TO THE RETURN LINE RESULTING IN A LOSS OF STEERING PRESSURE THAT COULD TRIP AN ERROR DETECTION CIRCUIT, AUTOMATICALLY DOWNMODING NWS TO THE FREE CASTOR MODE AND ANNUNCIATING THE NWS FAIL LIGHT.
FAILURE OPEN DURING FREE CASTOR HAS NO EFFECT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 329 ABORT: 2/1R

ITEM: VALVE, OVERLOAD CHECK (2 OF)
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) OVERLOAD CHECK VALVES (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/1R	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [2] B [F] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, WATER HAMMER

EFFECTS/RATIONALE:
THE OVERLOAD CHECK VALVES ARE FREE FLOATING BALL VALVES THAT RELIEVE EXCESSIVE PRESSURE BUILDUP ON THE OPERATIONAL SIDE OF THE ACTUATOR ASSEMBLY- EACH PROTECTING A SEPARATE LINE. THE VALVES FAILING CLOSED HAVE NO IMMEDIATE EFFECT ON NWS; HOWEVER, ANY EXCESSIVE PRESSURE BUILDUP (i.e. TIRE HITTING A BUMP/ROCK) WILL RESULT IN DAMAGE TO THE ACTUATOR ASSEMBLY AND THE LOSS OF NWS. FAILURE CLOSED DURING FREE CASTOR HAS NO EFFECT.
CLOSED MAY NOT BE CONSIDERED A CREDIBLE FAILURE MODE FOR THIS TYPE OF VALVE.
THE DIRECT MODE OF NWS WILL ALSO FAIL UNDER SIMILAR CIRCUMSTANCES. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. WHEN THE RUDDER BECOMES INEFFECTIVE, DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE IF NWS IS NOT AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 330

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: VALVE, PILOT SOLENOID 1
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTUATOR ASSEMBLY
3) PILOT VALVE 1: PILOT VALVE/ACTIVATION SOLENOID
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A22LV1 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, PIECE PART FAILURE (SPRING), SHORTED SOLENOID SIGNAL, BINDING

EFFECTS/RATIONALE:
WHEN PILOT VALVE 1 OPENS, THE NWS ACTUATOR ASSEMBLY'S SHUTOFF VALVE OPENS WHICH HYDRAULICALLY ENERGIZES THE ASSEMBLY. IF PILOT VALVE 1 FAILS OPEN, THERE IS NO EFFECT AS OPEN IS THE NORMAL OPERATING POSITION FOR THE VALVE DURING NWS. IN THE EVENT OF A SECOND FAILURE, PILOT VALVE 2 CAN STILL AUTOMATICALLY DOWNMODE NWS TO THE FREE CASTOR MODE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.
FAILURE OPEN DURING FREE CASTOR HAS NO EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 331 ABORT: 2/1R

ITEM: VALVE, PILOT SOLENOID 1
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTUATOR ASSEMBLY
3) PILOT VALVE 1: PILOT VALVE/ACTIVATION SOLENOID
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22LV1 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, LOSS OF CONTROL SIGNAL (OPEN COIL)

EFFECTS/RATIONALE:
WHEN PILOT VALVE 1 OPENS, THE NWS ACTUATOR ASSEMBLY'S SHUTOFF VALVE OPENS WHICH HYDRAULICALLY ENERGIZES THE ASSEMBLY. IF PILOT VALVE 1 FAILS CLOSED DURING NWS, THE SHUTOFF VALVE WILL CLOSE WHICH PREVENTS HYDRAULIC PRESSURE FROM ENTERING THE ACTUATOR ASSEMBLY. NWS WILL AUTOMATICALLY DOWNMODE TO FREE CASTOR AND THE PRESSURE SWITCH WILL OPEN - ANNUNCIATING THE NWS FAIL LIGHT. THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.
FAILURE CLOSED DURING FREE CASTOR HAS NO EFFECT.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 332 ABORT: 3/3

ITEM: VALVE, PILOT SOLENOID 2
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTUATOR ASSEMBLY
3) PILOT VALVE 2: PILOT VALVE/ACTIVATION SOLENOID
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A22LV2 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, PIECE PART FAILURE (SPRING), BINDING, SHORTED SOLENOID SIGNAL

EFFECTS/RATIONALE:
THE ACTIVATION OF PILOT VALVE 2 SUPPLIES THE HYDRAULIC PRESSURE TO THE ACTUATOR ASSEMBLY THAT OPENS THE BYPASS/CONTROL VALVES AND CLOSES THE HYDRAULIC PRESSURE SWITCH. IF PILOT VALVE 2 FAILS OPEN, THERE IS NO EFFECT AS OPEN IS THE NORMAL OPERATING POSITION FOR THE VALVE DURING NWS. IN THE EVENT OF A SECOND FAILURE, PILOT VALVE 1 CAN STILL AUTOMATICALLY DOWNMODE NWS TO THE FREE CASTOR MODE.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.
FAILURE OPEN DURING FREE CASTOR HAS NO EFFECT

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 333 ABORT: 2/1R

ITEM: VALVE, PILOT SOLENOID 2
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTUATOR ASSEMBLY
3) PILOT VALVE 2: PILOT VALVE/ACTIVATION SOLENOID
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22LV2 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, LOSS OF CONTROL SIGNAL (OPEN COIL)

EFFECTS/RATIONALE:
THE ACTIVATION OF PILOT VALVE 2 SUPPLIES HYDRAULIC PRESSURE THAT OPENS THE BYPASS/CONTROL VALVES AND CLOSES THE HYDRAULIC PRESSURE SWITCH. IF PILOT VALVE 2 FAILS CLOSED, THE BYPASS VALVES WILL CLOSE WHICH PREVENTS FLUID FROM ENTERING THE NWS ACTUATOR BALANCE AREA AND OPENS THE PRESSURE SWITCH WHICH ANNUNCIATES THE NWS FAIL LIGHT.
FAILING CLOSED DURING FREE CASTOR HAS NO EFFECT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 334

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: VALVE, RELIEF/CONTROL/BYPASS
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) RELIEF/CONTROL/BYPASS VALVES (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, PIECE PART FAILURE (SPRING)

EFFECTS/RATIONALE:
THE BYPASS VALVES CLOSE DURING FREE CASTOR AND SHUT OFF THE HYDRAULIC LINES FROM THE E-H SERVO VALVE TO THE ACTUATOR BALANCE AREA. IF THE VALVES FAIL OPEN DURING NWS, THERE IS NO EFFECT EXCEPT ONE HARDWARE PATH FOR DOWNMODING NWS TO FREE CASTOR IS LOST.
IF THE VALVES FAIL OPEN DURING FREE CASTOR, THERE IS SOME DEGREDATION IN THE SHIMMY DAMPING CAPABILITY OF THE SYSTEM. THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 335 ABORT: 2/1R

ITEM: VALVE, RELIEF/CONTROL/BYPASS
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) RELIEF/CONTROL/BYPASS VALVES (2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, LOSS OF HYDRAULIC CONTROL PRESSURE

EFFECTS/RATIONALE:
THE BYPASS VALVES CLOSE DURING FREE CASTOR AND SHUT OFF THE HYDRAULIC LINES FROM THE E-H SERVO VALVE TO THE ACTUATOR PISTON BALANCE AREA. IF THE VALVES FAIL CLOSED, HYDRAULIC PRESSURE WILL NOT REACH THE ACTUATOR PISTON. THE RESULTING LOSS OF STEERING RESPONSE WILL TRIP AN ERROR DETECTION CIRCUIT, AUTOMATICALLY DOWNMODING NWS TO THE FREE CASTOR MODE AND ANNUNCIATING THE NWS FAIL LIGHT.
IF THE VALVES FAIL CLOSED IN FREE CASTOR, THERE IS NO EFFECT. THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEERING THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 336

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: VALVE, SHUTOFF
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) SHUTOFF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING, PIECE PART FAILURE (SPRING)

EFFECTS/RATIONALE:
THE SPRING LOADED SHUTOFF VALVE PORTS OR BLOCKS HYDRAULIC FLUID TO THE ACTUATOR ASSEMBLY. IF THE VALVE FAILS OPEN THERE IS NO EFFECT ON NWS EXCEPT ONE HARDWARE PATH FOR DOWNMODING NWS IS LOST. PILOT VALVE No. 2 CAN STILL DOWNMODE NWS.
FAILURE OPEN DURING FREE CASTOR HAS NO EFFECT.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 337

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 2/1R
ABORT: 2/1R

ITEM: VALVE, SHUTOFF
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) NWS ACTUATOR ASSEMBLY
3) SHUTOFF VALVE
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 21V51A22 (ACTUATOR ASSEMBLY); NOSE GEAR STRUT
PART NUMBER: MC621-0058-0010 (ACTUATOR ASSEMBLY)

CAUSES: CONTAMINATION, BINDING

EFFECTS/RATIONALE:
THE SPRING LOADED SHUTOFF VALVE PORTS OR BLOCKS HYDRAULIC FLUID TO THE ACTUATOR ASSEMBLY. IF THE VALVE FAILS CLOSED, HYDRALIC PRESSURE WILL NOT REACH THE ACTUATOR PISTON BALANCE AREA. THE RESULTING LOSS IN STEERING RESPONSE WILL TRIP AN ERROR DETECTION CIRCUIT, AUTOMATICALLY DOWNMODE NWS TO THE FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT.
IF THE VALVE FAILS CLOSED DURING FREE CASTOR THERE IS NO EFFECT. THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEERING THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 401

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: LIGHT, NWS FAIL
FAILURE MODE: FAILS OFF

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) FAILURE ANNUNCIATOR ASSEMBLY (EPD&C)
3) NWS FAIL LIGHT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 34V73A3-XDS3; PANEL F3 (F2 ON OV-102)
PART NUMBER: MC434-0075-0011

CAUSES: VIBRATION, MECHANICAL SHOCK, OPEN CONTACT

EFFECTS/RATIONALE:
IF THE NWS FAIL LIGHT FAILS OFF, EARLY FAILURE DETECTION CAPABILITY IS LOST AND CREW RECOGNITION OF SECOND NWS FAILURE WOULD BE 'AFTER THE FACT'- RESULTING IN THE NEED FOR A MORE TIME CRITICAL CORRECTIVE ACTION.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3000 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 402 ABORT: 2/1R

ITEM: ASSEMBLY, ANNUNCIATOR CONTROL
FAILURE MODE: SHORTED/PREMATURE SIGNAL (NWS FAIL LIGHT ON)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) FAILURE ANNUNCIATOR ASSEMBLY
3) ANNUNCIATOR CONTROL ASSEMBLY
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 30V73A18; FLIGHT DECK
PART NUMBER: MC434-0283-0002

CAUSES: VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE FAILED ASSEMBLY CAUSES THE PREMATURE ANNUNCIATION OF THE NWS FAIL LIGHT. THE LIGHT SERVES AS A FALSE INDICATION TO THE CREW THAT THE NWS SYSTEM IS NOT RELIABLE. THE CREW WOULD RESPOND BY TOGGLING THE NWS SWITCH TO OFF WHICH MANUALLY DOWNMODES NWS TO THE FREE CASTOR MODE. SWITCHING TO THE DIRECT MODE OF NWS WOULD NOT EXTINGUISH THE FAIL LIGHT.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 403

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: ASSEMBLY, ANNUNCIATOR CONTROL
FAILURE MODE: OPEN/LOSS OF OUTPUT SIGNAL

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) FAILURE ANNUNCIATOR ASSEMBLY
3) ANNUNCIATOR CONTROL ASSEMBLY
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 30V73A18; FLIGHT DECK
PART NUMBER: MC434-0283-0002

CAUSES: VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE LOSS OF THE CONTROL ASSEMBLY OUTPUT SIGNAL INHIBITS THE ANNUNCIATION OF THE NWS FAIL LIGHT. AS A RESULT, EARLY FAILURE DETECTION CAPABILITY IS LOST AND CREW RECOGNITION OF A SECOND NWS FAILURE WOULD BE AFTER THE FACT- RESULTING IN THE NEED FOR A MORE TIME CRITICAL CORRECTIVE ACTION.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 404 ABORT: 2/1R

ITEM: ASSEMBLY, FORWARD LOAD CONTROL (TYPE III HYBRID DRIVER CONTROLLER)
FAILURE MODE: SHORTED/PREMATURE SIGNAL

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) FAILURE ANNUNCIATOR ASSEMBLY (EPD&C)
3) TYPE III HYBRID DRIVER CONTROLLER: FLCA No. 3
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 83V76A18; AVIONICS BAY No. 3A
PART NUMBER: MC450-0056-0001

CAUSES: VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE PREMATURE SIGNAL FROM THE DRIVER RESULTS IN THE ANNUNCIATION OF THE NWS FAIL LIGHT. THE LIGHT SERVES AS A FALSE INDICATION TO THE CREW THAT THE NWS SYSTEM MAY NOT BE RELIABLE. THE CREW WOULD RESPOND BY TOGGLING THE NWS SWITCH TO OFF WHICH MANUALLY DOWNMODES NWS TO THE FREE CASTOR MODE. SWITCHING TO THE DIRECT MODE OF NWS WOULD NOT EXTINGUISH THE FAIL LIGHT. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3004 (CRIT 2/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 405 ABORT: 3/3

ITEM: ASSEMBLY, FORWARD LOAD CONTROL (TYPE III HYBRID DRIVER CONTROLLER)
FAILURE MODE: OPEN/LOSS OF OUTPUT SIGNAL

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) FAILURE ANNUNCIATOR ASSEMBLY (EPD&C)
3) TYPE III HYBRID DRIVER CONTROLLER: FLCA No. 3
4)
5)
6)
7)
8)
9)

	CRITICALITIES		
FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 83V76A18; AVIONICS BAY No. 3A
PART NUMBER: MC450-0056-0001

CAUSES: VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE

EFFECTS/RATIONALE:
THE LOSS OF THE DRIVER OUTPUT SIGNAL INHIBITS THE ANNUNCIATION OF THE NWS FAIL LIGHT. AS A RESULT, EARLY FAILURE DETECTION CAPABILITY IS LOST AND CREW RECOGNITION OF A SECOND NWS FAILURE WOULD BE AFTER THE FACT- RESULTING IN THE NEED FOR A MORE TIME CRITICAL CORRECTIVE ACTION.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3003 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 501 ABORT: 2/1R

ITEM: CIRCUIT BREAKER (CB 023)
FAILURE MODE: FAILS OPEN

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) CIRCUIT BREAKER 023
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 33V73A14-CB023; PANEL O14
PART NUMBER: MC454-0026-2050

CAUSES: VIBRATION, MECHANICAL SHOCK, OPEN CONTACT

EFFECTS/RATIONALE:
CB23 PROVIDES NWS CIRCUIT PROTECTION FROM MAIN BUS A WHICH IS THE ONLY SOURCE OF POWER FOR NWS. FAILING CB23 OPEN WILL REMOVE ELECTRICAL POWER TO NWS RESULTING IN AN AUTOMATIC DOWNMODE TO FREE CASTOR AND THE ANNUNCIATION OF THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.
THE NWS SYSTEM WILL ALWAYS HAVE A SINGLE POINT FAILURE AS LONG AS THE SYSTEM HAS ONLY ONE POWER SOURCE.

REFERENCES: EPD&C 3001 (CRIT 2/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 502

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: CIRCUIT BREAKER (CB 023)
FAILURE MODE: FAILS CLOSED

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) CIRCUIT BREAKER 023
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 33V73A14-CB023; PANEL O14
PART NUMBER: MC454-0026-2050

CAUSES: VIBRATION, MECHANICAL SHOCK, SHORTED CONTACT

EFFECTS/RATIONALE:
CB23 PROVIDES NWS CIRCUIT PROTECTION FROM MAIN BUS A WHICH IS THE ONLY SOURCE OF POWER FOR NWS. FAILING CB23 CLOSED HAS NO EFFECT EXCEPT THE LOSS OF PROTECTION AGAINST HIGH CURRENT/VOLTAGE SPIKES. CLOSED IS THE NORMAL OPERATING MODE FOR CB23 DURING NWS. POWER TO THE NWS SYSTEM CAN STILL BE CONTROLLED BY THE NWS TOGGLE SWITCH. NWS CAN STILL BE DISENGAGED BY THE ERROR DETECTION CIRCUITS, THE NOSE WHEEL POSITION SOP OR THE NWS SWITCH. THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3002 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 1/1
MDAC ID: 503 ABORT: 1/1

ITEM: INDICATOR, PUSH BUTTON: ROLL/YAW (CSS/AUTO)
FAILURE MODE: JAMS TO ACTIVE CONTACT (CSS/AUTO)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM
3) PUSH BUTTON INDICATOR: ROLL/YAW (CSS/AUTO)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	1/1
LIFTOFF:	/NA	TAL:	1/1
ONORBIT:	/NA	AOA:	1/1
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	1/1		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AREA 30 (FLIGHT DECK); PANELS F2,F4
PART NUMBER: ME452-0061-7141,-7142

CAUSES: CONTAMINATION, VIBRATION, MECHANICAL SHOCK, PIECE PART FAILURE (SPRING)

EFFECTS/RATIONALE:
THE ROLL/YAW (CSS/AUTO) PBIs CONFIGURE THE FLIGHT CONTROL (DAP) TO EITHER MANUAL OR AUTO GUIDANCE (AUTOLAND) CONTROL. JAMMING THE SWITCH TO CSS HAS NO EFFECT. JAMMING THE SWITCH TO AUTO RESULTS IN THE LOSS OF ALL MANUAL DIRECTIONAL CONTROL AND POSSIBLE LOSS OF VEHICLE. THE ORBITER RELIES SOLELY ON THE RUDDER FOR DIRECTIONAL CONTROL BETWEEN MGTD AND NGTD AND AUTOLAND REQUIRES A RUNWAY WITH MSBLS FOR EFFECTIVE STEERING COMMAND GENERATION. MANUAL OVERRIDE OF THE JAMMED AUTO IS POSSIBLE IF THE CSS PBI IS HELD DEPRESSED; HOWEVER THIS IS AN OFF-NOMINAL PROCEDURE. AFTER NGTD, THE DIRECT MODE OF NWS IS AVAILABLE BUT THE RUDDER, WHICH WOULD STILL BE CONTROLLED BY AUTOLAND GUIDANCE, MAY OPPOSE THE TURNING EFFECT OF THE NW. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/20/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 504 ABORT: 3/1R

ITEM: INDICATOR, PUSH BUTTON: ROLL/YAW (CSS/AUTO)
FAILURE MODE: FAILS TO RESPOND

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM
3) PUSH BUTTON INDICATOR: ROLL/YAW (CSS/AUTO)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: AREA 30 (FLIGHT DECK); PANELS F2,F4
PART NUMBER: ME452-0061-7141,-7142

CAUSES: CONTAMINATION, VIBRATION, MECHANICAL SHOCK, OPEN RESISTOR

EFFECTS/RATIONALE:
THE ROLL/YAW (CSS/AUTO) PBIs CONFIGURE THE FLIGHT CONTROL (DAP) TO EITHER MANUAL OR AUTO GUIDANCE (AUTOLAND) CONTROL. FIRST FAILURE WILL HAVE NO EFFECT, RM WILL DOWNMODE TO LAST OUTPUT. AUTO/CSS CAN BE SELECTED FROM THE OTHER CREWMEMBER'S STATION. CSS CONFIGURATION CAN BE SELECTED BY DEFLECTING THE RHC.
LOSS OF ALL REUNDANCY CAUSES THE LOSS OF ALL MANUAL DIRECTIONAL CONTROL AND POSSIBLE LOSS OF VEHICLE. THE ORBITER RELIES SOLELY ON THE RUDDER FOR DIRECTIONAL CONTROL BETWEEN MGTD AND NGTD AND AUTOLAND REQUIRES A RUNWAY WITH MSBLS FOR EFFECTIVE STEERING COMMAND GENERATION.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES:

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 505 ABORT: 3/3

ITEM: RESISTORS, ISOLATION (3)
FAILURE MODE: HIGH RESISTANCE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) ISOLATION RESISTORS (3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 31V73A2A1-A6R1, -A6R2, -A6R3; PANEL L2A1
PART NUMBER: RLR070512GR

CAUSES: VIBRATION, MECHANICAL SHOCK, THERMAL STRESS

EFFECTS/RATIONALE:
THE ISOLATION RESISTORS PROVIDE NWS STATUS MONITORING CIRCUIT PROTECTION FROM THE MAIN POWER BUSES.
FAILING THE RESISTORS HIGH HAS NO EFFECT ON NWS. NWS MODE INTERPRETATION LOGIC IS USED TO DETERMINE THE ACTIVE MODE OF NWS. DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3007 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86
SUBSYSTEM: NWS
MDAC ID: 506

HIGHEST CRITICALITY HDW/FUNC
FLIGHT: 3/3
ABORT: 3/3

ITEM: RESISTORS, ISOLATION (3)
FAILURE MODE: LOW RESISTANCE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) ISOLATION RESISTORS (3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 31V73A2A1-A6R1, -A6R2, -A6R3; PANEL L2A1
PART NUMBER: RLR070512GR

CAUSES: VIBRATION, MECHANICAL SHOCK, THERMAL STRESS

EFFECTS/RATIONALE:
THE ISOLATION RESISTORS PROVIDE NWS STATUS MONITORING CIRCUIT PROTECTION FROM THE MAIN POWER BUSES.
FAILING THE RESISTORS LOW HAS NO EFFECT EXCEPT THE LOSS OF PROTECTION FROM CURRENT/VOLTAGE SPIKES.
DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3007 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 507 ABORT: 3/3

ITEM: RESISTOR, CURRENT LIMIT
FAILURE MODE: HIGH RESISTANCE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) CURRENT LIMIT RESISTOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 31V73A2A1-A5R2; PANEL L2A1
PART NUMBER: RLR320201GR

CAUSES: VIBRATION, MECHANICAL SHOCK, THERMAL STRESS

EFFECTS/RATIONALE:
THE CURRENT LIMIT RESISTOR PROVIDES CIRCUIT PROTECTION TO ONE PATH OF THE NWS FAILURE ANNUNCIATION CIRCUITRY FROM POWER BUS AB1. HIGH RESISTANCE WOULD CUTOFF AB1 POWER AND INHIBIT THE HARDWIRED PATH FOR NWS FAILURE ANNUNCIATION.
THE FAILURE DETECTION LOGIC STILL OPERATES AND WILL DOWNMODE THE SYSTEM IN THE EVENT OF ANOTHER DETECTABLE FAILURE.
DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3008 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 508 ABORT: 3/3

ITEM: RESISTOR, CURRENT LIMIT
FAILURE MODE: LOW RESISTANCE

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) CURRENT LIMIT RESISTOR
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 31V73A2A1-A5R2; PANEL L2A1
PART NUMBER: RLR320201GR

CAUSES: VIBRATION, MECHANICAL SHOCK, THERMAL STRESS

EFFECTS/RATIONALE:
THE CURRENT LIMIT RESISTOR PROVIDES CIRCUIT PROTECTION TO ONE PATH OF THE NWS FAILURE ANNUNCIATION CIRCUITRY FROM POWER BUS AB1. A FAILURE OF LOW RESISTANCE HAS NO EFFECT ON NWS EXCEPT THE CIRCUIT PROTECTION AGAINST HIGH CURRECT/VOLTAGE SPIKES IS LOST. DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3008 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/3
MDAC ID: 509 ABORT: 3/3

ITEM: SWITCH, NWS TOGGLE (3 POSITION)
FAILURE MODE: FAILS TO ANY ACTIVE CONTACT (GPC OR DIRECT)

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) NWS 3 POSITION TOGGLE SWITCH: OFF/GPC/DIRECT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/3
LIFTOFF:	/NA	TAL:	3/3
ONORBIT:	/NA	AOA:	3/3
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/3		

REDUNDANCY SCREENS: A [NA] B [NA] C [NA]

LOCATION: 31V73A21A1-S6; PANEL L2A1
PART NUMBER: ME452-0102-7373

CAUSES: PIECE PART FAILURE, CONTAMINATION, VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
THE NWS TOGGLE SWITCH SELECTS THE MODE OF NWS TO BE ACTIVATED. IF THE SWITCH FAILS TO GPC, THERE IS NO EFFECT EXCEPT THE CAPABILITY TO DESELECT NWS USING THE SWITCH WOULD BE LOST.
THE SWITCH FAILING TO DIRECT WOULD RESULT IN THE LOSS OF THE GPC WRAPAROUND PROTECTION, COMMAND LIMITING/FADING, AND LATERAL ACCELERATION FEEDBACK; BUT THE MAXIMUM COMMANDED NW DEFLECTION WOULD INCREASE FROM 5 TO 9 DEG.
IF BOTH ACTIVE CONTACTS FAIL ON, NWS IS DEFAULTED TO GPC MODE. RUDDER PEDAL CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: EPD&C 3006 (CRIT 3/3)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 510 ABORT: 2/1R

ITEM: SWITCH, NWS TOGGLE (3 POSITION)
FAILURE MODE: FAILS OFF

LEAD ANALYST: AS MEDIAVILLA SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS
2) ACTIVATION SYSTEM (EPD&C)
3) NWS 3 POSITION TOGGLE SWITCH: OFF/GPC/DIRECT
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 31V73A21A1-S6; PANEL L2A1
PART NUMBER: ME452-0102-7373

CAUSES: PIECE PART FAILURE, CONTAMINATION, VIBRATION, MECHANICAL SHOCK

EFFECTS/RATIONALE:
THE NWS TOGGLE SWITCH SELECTS THE MODE OF NWS TO BE ACTIVATED. IF THE SWITCH FAILS OFF, POWER WILL NOT REACH THE SYSTEM AND NWS WILL AUTOMATICALLY DOWNMODE TO FREE CASTOR MODE AND THE NWS FAIL LIGHT WILL ANNUNCIATE.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES: EPD&C 3005 (CRIT 2/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 601 ABORT: 2/1R

ITEM: MDM FF1
FAILURE MODE: LOSS OF OUTPUT/POWER LOSS

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF1)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A3; FWD AVIONICS BAY No. 1
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF1 PROCESSES THE NW_ENABLE_1 COMMAND AND ONE CHANNEL OF BOTH THE RPTA AND THE SPA. LOSS OF THE NW_ENABLE_1 BIT WILL AUTOMATICALLY DOWNMODE THE NWS SYSTEM TO THE FREE CASTOR MODE AND CAUSE THE NWS FAIL LIGHT TO ANNUNCIATE.
THE DIRECT MODE OF NWS WILL ALSO FAIL. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING MUST BE USED TO STEER THE VEHICLE WHEN THE RUDDER BECOMES INEFFECTIVE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 602 ABORT: 2/1R

ITEM: MDM FF1
FAILURE MODE: STUCK ON LAST OUTPUT/STUCK ON BUSY

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF1)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A3; FWD AVIONICS BAY No. 1
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF1 PROCESSES THE NW_ENABLE_1 COMMAND AND ONE CHANNEL OF BOTH THE RPTA AND THE SPA. IF THE FAILURE OCCURRED BEFORE NGTD, THE LOSS OF THE NW_ENABLE_1 COMMAND WOULD INHIBIT NWS (GPC AND DIRECT) ACTIVATION.
IF THE FAILURE OCCURRED AFTER NGTD, THERE WOULD BE NO EFFECT; THE FAILURE DETECTION CIRCUITRY IS STILL OPERABLE AND CAPABLE OF DOWNMODING THE SYSTEM.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 603 ABORT: 2/1R

ITEM: MDM FF1
FAILURE MODE: PREMATURE OUTPUT/SELECT ALL CHANNELS WRONG

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF1)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A3; FWD AVIONICS BAY No. 1
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF1 PROCESSES THE NW_ENABLE_1 COMMAND AND ONE CHANNEL OF BOTH THE RPTA AND THE SPA. PREMATURE OUTPUT OF NW_ENABLE_1 WOULD HAVE NO EFFECT SINCE NW_ENABLE_2 COMMAND IS ALSO NEEDED TO ACTIVATE NWS.
SELECTING ALL CHANNELS WRONG AFTER NGTD WOULD AUTOMATICALLY DOWNMODE NWS (GPC AND DIRECT) TO THE FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 604 ABORT: 3/1R

ITEM: MDM FF2
FAILURE MODE: LOSS OF OUTPUT/POWER LOSS

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A4; FWD AVIONICS BAY No. 2
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF2 PROCESSES THE GPC STEERING COMMAND, THE NWS_COMPUTER_ON SIGNAL, THE NW_ENABLE_2 SIGNAL, ONE CHANNEL OF BOTH THE RPTA AND THE SPA, AND THE LANDING GEAR PROXIMITY SENSOR DATA. LOSS OF THE NW_ENABLE_2 BIT WILL AUTOMATICALLY DOWNMODE THE NWS SYSTEM TO THE FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 605 ABORT: 3/1R

ITEM: MDM FF2
FAILURE MODE: STUCK ON LAST OUTPUT/STUCK ON BUSY

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A4; FWD AVIONICS BAY No. 2
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF2 PROCESSES THE GPC STEERING COMMAND, THE NWS_COMPUTER_ON SIGNAL, THE NW_ENABLE_2 SIGNAL, ONE CHANNEL OF BOTH THE RPTA AND THE SPA, AND THE LANDING GEAR PROXIMITY SENSOR DATA. IF THE FAILURE OCCURRED BEFORE NGTD, THE LOSS OF THE NW_ENABLE_2 BIT WOULD INHIBIT THE ACTIVATION OF NWS IN THE GPC MODE. IF THE FAILURE OCCURRED AFTER NGTD, THE GPC STEERING COMMAND INPUT WOULD CAUSE A MISCOMPARE IN THE NW POSITION SOP WHICH WOULD AUTOMATICALLY DOWNMODE NWS TO THE FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 606 ABORT: 3/1R

ITEM: MDM FF2
FAILURE MODE: PREMATURE OUTPUT/SELECT ALL CHANNELS WRONG

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF2)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A4; FWD AVIONICS BAY No. 2
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF2 PROCESSES THE GPC STEERING COMMAND, THE NWS_COMPUTER_ON SIGNAL, THE NW_ENABLE_2 SIGNAL, ONE CHANNEL OF BOTH THE RPTA AND THE SPA, AND THE LANDING GEAR PROXIMITY SENSOR DATA. PREMATURE OUTPUT WULD HAVE NO EFFECT.
SELECTING ALL CHANNELS WRONG AFTER NGTD WOULD AUTOMATICALLY DOWNMODE NWS TO THE FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 607 ABORT: 3/1R

ITEM: MDM FF3
FAILURE MODE: LOSS OF OUTPUT/POWER LOSS

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A5; FWD AVIONICS BAY No. 3A
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF3 PROCESSES THE NW_MAN_ON SIGNAL, ONE CHANNEL OF THE RPTA, AND THE LANDING GEAR PROXIMITY DATA. THE ONLY EFFECT OF THE FAILURE IS THE LOSS OF ONE PATH OF REDUNDANCY. THE CAPABILITY TO DESELECT GPC AND THEN SELECT DIRECT MODE OF NWS WOULD BE LOST; HOWEVER, IF THE FF3 FAILURE OCCURRED WHILE IN THE DIRECT MODE OF NWS, THERE WOULD BE NO EFFECT. RM MAINTAINS THE ENABLES WITH NW_ACTIVE_STATUS ON.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 608 ABORT: 3/1R

ITEM: MDM FF3
FAILURE MODE: STUCK ON LAST OUTPUT/STUCK ON BUSY MODE

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A5; FWD AVIONICS BAY No. 3A
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF3 PROCESSES THE NW_MAN_ON SIGNAL, ONE CHANNEL OF THE RPTA, AND THE LANDING GEAR PROXIMITY DATA. THE ONLY EFFECT OF THE FAILURE IS THE LOSS OF ONE PATH OF REDUNDANCY. THE CAPABILITY TO DESELECT GPC AND THEN SELECT DIRECT MODE OF NWS WOULD BE LOST; HOWEVER, IF THE FF3 FAILURE OCCURRED WHILE IN THE DIRECT MODE OF NWS THERE WOULD BE NO EFFECT.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 609 ABORT: 3/1R

ITEM: MDM FF3
FAILURE MODE: PREMATURE OUTPUT/SELECT ALL CHANNELS WRONG

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF3)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A5; FWD AVIONICS BAY No. 3A
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF3 PROCESSES THE NW MAN ON SIGNAL, ONE CHANNEL OF THE RPTA, AND THE LANDING GEAR PROXIMITY DATA. THE ONLY EFFECT OF THE FAILURE IS THE LOSS OF ONE PATH OF REDUNDANCY. PREMATURE OUTPUT WOULD HAVE NO EFFECT; RM SOLVES DILEMMA OF TWO "ON" SIGNALS. IF THE DIRECT MODE WERE ACTIVE AND ALL CHANNELS WERE SELECTED WRONG, THE RM STILL MAINTAINS THE ENABLE SIGNALS. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 610 ABORT: 3/1R

ITEM: MDM FF4
FAILURE MODE: LOSS OF OUTPUT/POWER LOSS

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF4)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A6; FWD AVIONICS BAY No. 2
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF4 PROCESSES THE NW_ACTIVE_STATUS SIGNAL, THE NW_POS_ERROR SIGNAL AND ONE CHANNEL OF THE SPA. THE ACTIVE STATUS IS ONLY USED BY RM. THE FAILURE DETECTION CIRCUITS ARE STILL ACTIVE AND COULD STILL DOWNMODE THE NWS SYSTEM TO THE FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT VIA THE HARDWIRED PATH IF ANOTHER DETECTABLE FAILURE OCCURRED.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 3/1R
MDAC ID: 611 ABORT: 3/1R

ITEM: MDM FF4
FAILURE MODE: STUCK ON LAST OUTPUT/STUCK ON BUSY MODE

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF4)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	3/1R
LIFTOFF:	/NA	TAL:	3/1R
ONORBIT:	/NA	AOA:	3/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	3/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A6; FWD AVIONICS BAY No. 2
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF4 PROCESSES THE NW_ACTIVE_STATUS SIGNAL, THE NW_POS_ERROR SIGNAL AND ONE CHANNEL OF THE SPA. THE ACTIVE STATUS IS ONLY USED BY RM. THE FAILURE DETECTION CIRCUITS ARE STILL ACTIVE AND COULD STILL DOWNMODE THE NWS SYSTEM TO THE FREE CASTOR MODE AND ANNUNCIATE THE NWS FAIL LIGHT VIA THE HARDWIRED PATH IF ANOTHER DETECTABLE FAILURE OCCURRED.
THE DIRECT MODE OF NWS IS STILL AVAILABLE. RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

INDEPENDENT ORBITER ASSESSMENT

DATE: 11/17/86 HIGHEST CRITICALITY HDW/FUNC
SUBSYSTEM: NWS FLIGHT: 2/1R
MDAC ID: 612 ABORT: 2/1R

ITEM: MDM FF4
FAILURE MODE: PREMATURE OUTPUT/SELECT ALL CHANNELS WRONG

LEAD ANALYST: A HOCHSTEIN SUBSYS LEAD: A HOCHSTEIN

BREAKDOWN HIERARCHY:
1) NWS/DPS
2) MULTIPLEXER/DEMULTIPLEXER (MDM)
3) FLIGHT CRITICAL FORWARD MDM (FF4)
4)
5)
6)
7)
8)
9)

CRITICALITIES

FLIGHT PHASE	HDW/FUNC	ABORT	HDW/FUNC
PRELAUNCH:	/NA	RTLS:	2/1R
LIFTOFF:	/NA	TAL:	2/1R
ONORBIT:	/NA	AOA:	2/1R
DEORBIT:	/NA	ATO:	/NA
LANDING/SAFING:	2/1R		

REDUNDANCY SCREENS: A [1] B [P] C [P]

LOCATION: 81V72A6; FWD AVIONICS BAY No. 2
PART NUMBER: MC615-0004-5100

CAUSES: VIBRATION, CONTAMINATION, CORROSION

EFFECTS/RATIONALE:
MDM FF4 PROCESSES THE NW_ACTIVE_STATUS SIGNAL, THE NW_POS_ERROR SIGNAL AND ONE CHANNEL OF THE SPA. THE ACTIVE STATUS IS ONLY USED BY RM. A PREMATURE NW_POS_ERROR SET TO TRUE WOULD CAUSE THE NWS FAIL LIGHT TO ANNUNCIATE. THE CREW WOULD MANUALLY DOWNMODE NWS TO THE FREE CASTOR MODE BY TOGGLING THE NWS SWITCH TO OFF. SWITCHING TO THE DIRECT MODE OF NWS WOULD NOT EXTINGUISH THE NWS FAIL LIGHT.
RUDDER CONTROL OF THE VEHICLE IS AVAILABLE AT EFFECTIVE SPEEDS. DIFFERENTIAL BRAKING IS A MODE OF STEERING THAT IS STILL AVAILABLE.

REFERENCES: DPS100-DPS108 (CRIT 3/1R)

APPENDIX D
POTENTIAL CRITICAL ITEMS

MDAC ID	ITEM	FAILURE MODE
101	PEDALS, RUDDER	JAMMED
102	PEDALS, RUDDER	LOSS OF LINKAGE
103	TRANSDUCER, COMMAND	NO OUTPUT
104	TRANSDUCER, COMMAND	ERRONEOUS OUTPUT
107	RPTA	NO OUTPUT
108	RPTA	ERRONEOUS OUTPUT
201	BOX, NWS CNTL-FAILURE DETECT	FAILS ON (DETECTS)
202	BOX, NWS CNTL-PILOT VALVE CNTL	OPEN (LOSS OF SIGNAL)
205	BOX, NWS CNTL-STEERING SIGNAL	LOSS OF OUTPUT
206	BOX, NWS CNTL-STEERING SIGNAL	ERRONEOUS OUTPUT
301	ACCUMULATOR	OPEN
302	ACCUMULATOR	CLOSED
307	NWS ACTUATOR HYD HOUSING	RUPTURE
308	PISTON, ACTUATOR ARM	JAMMED
309	PISTON, ACTUATOR ARM	BROKEN LINKAGE
310	FILTER, INLET	OPEN
311	FILTER, INLET	CLOSED
312	HOSE ASSEMBLY (ACTUATOR)	RUPTURE
313	HOSE ASSEMBLY (ACTUATOR)	BLOCKED
314	SWITCH, PRESSURE	OPEN
316	TRANSDUCER, FEEDBACK	NO OUTPUT
317	TRANSDUCER, FEEDBACK	ERRONEOUS OUTPUT
322	VALVE, ANTI-CAVITATION (2)	OPEN/LEAKAGE
323	VALVE, E-H SERVO CONTROL	FAILS TO RESPOND
324	VALVE, E-H SERVO CONTROL	ERRATIC OPERATION
325	VALVE, E-H PROTECT/ISOLATION	OPEN
326	VALVE, E-H PROTECT/ISOLATION	CLOSED
328	VALVE, OVERLOAD CHECK (2)	OPEN
329	VALVE, OVERLOAD CHECK (2)	CLOSED
331	VALVE, PILOT SOLENOID No.1	CLOSED
333	VALVE, PILOT SOLENOID No.2	CLOSED
335	VALVE, RELIEF/CONTROL/BYPASS	CLOSED (BYPASSES)
337	VALVE, SHUTOFF	CLOSED
402	ASSEMBLY, ANNUNCIATOR CNTL	PREMATURE SIGNAL
404	DRIVER, HYBRID TYPE III	PREMATURE SIGNAL
501	BREAKER, CIRCUIT 023	OPEN
503	PBI, ROLL/YAW CSS/AUTO	JAMMED (TO AUTO)
510	SWITCH, NWS TOGGLE	OFF
601	MDM FF1	LOSS OF OUTPUT
602	MDM FF1	STUCK-LAST OUTPUT
603	MDM FF1	ALL CHNLS WRONG
612	MDM FF4	ALL CHNLS WRONG